Multi-hazard Loss Estimation Methodology

Flood Model

HAZUS®*MH* MR3

User Manual

Developed by:
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Foreword

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Message to Users

The HAZUS Flood Model produces loss estimates for vulnerability assessments and plans for flood risk mitigation, emergency preparedness, and response and recovery. The methodology deals with nearly all aspects of the built environment, and a wide range of losses. The user can evaluate losses from a single flood event, or for a range of flood events allowing for annualized estimates of damages. Using the extensive national databases that are embedded in HAZUS, users can make general loss estimates for a region. These databases contain information such as demographic aspects of the population in a study region, square footage for different occupancies of buildings, and numbers and locations of bridges. The HAZUS methodology and software are flexible enough so that locally developed inventories and other data that more accurately reflect the local environment can be substituted, resulting in improved loss estimates.

The methods within the HAZUS Flood Model are commonly used by federal, state, and local agencies for planning studies and are considered "reasonable." Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning floods and their effects upon buildings and facilities. They also result from the approximations that are necessary for comprehensive analyses. Factors such as incomplete or inaccurate inventories of the built environment, demographics and economic parameters can result in a range of uncertainty of two or more in loss estimates produced by the HAZUS Flood Model.

Users should be aware of the following specific limitations:

- While the HAZUS Flood Model can be used to estimate losses for an individual building, the results must be considered as average for a group of similar buildings.

- When using embedded inventories, accuracy of losses associated with lifelines may be less than for losses from the general building stock. The embedded databases and assumptions used to characterize the lifeline systems in a study region are necessarily incomplete and oversimplified.

- The Flood Model performs its analysis at the census block level with small numbers of buildings. Damage analysis of these small numbers makes the Flood Model more sensitive to rounding errors. These results should be used with suitable caution.

HAZUS should still be regarded as a work in progress. Additional damage and loss data from actual floods and further experience in using the software will contribute to improvements in future releases. To assist us in further improving HAZUS, users are invited to submit comments on methodological and software issues by letter, fax or e-mail to:

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Limitations of the HAZUS-MH MR3 Software

Installation

- HAZUS-MH MR3 is certified to run on ArcGIS 9.2 SP2. Tests have shown that HAZUS-MH MR3 is unable to fully function on the ArcGIS 9.2 platform only, SP1 is required, but SP2 is preferable. ArcGIS 9.2 SP2 is available from the ESRI website.

- HAZUS-MH MR3 is certified to run on MS Windows 2000 SP2, SP3 and SP4 and Windows XP SP1 and SP2. A user is allowed to install HAZUS-MH MR3 on MS Windows 2000 and XP for Service Packs higher than SP4 and SP2 respectively, but HAZUS-MH MR3 is not certified to work flawlessly with those service packs.

- HAZUS-MH MR3 must be uninstalled only with the Windows Add/Remove Programs utility. For details on uninstalling, please consult the User Manuals.

- Users who plan to operate HAZUS-MH MR3 in a network environment will be able to perform HAZUS operations, such as importing, but not study region creation.

Study Region Size

- The database management system of HAZUS-MH MR3 is SQL Server 2005 Express Edition. This system has a size limit of 4 GB per database, which limits the size of the regions to 90,000 census blocks for a Riverine or Coastal flood analysis. Ninety thousand census blocks approximates four counties and is equivalent to an area with a population of about 9 million. For a multi-hazard study region that includes data for all three hazards, the 4 GB limit will permit an even smaller study region. To work around this, the full version of Microsoft SQL Server must be used (see Appendix H in the User Manual).

- Multihazard loss analysis capability is limited to the 23 states that experience hurricane, flood and earthquake hazards and requires that the user first run annualized losses for each of the three hazards.

- To maximize the size of the study region that may be analyzed, set the virtual memory size from a minimum of 2048 MB to a maximum of 4096 MB. For the earthquake model, the virtual memory size may be increased from a minimum of 1024 MB to a maximum of 2048 MB for optimal operation. Here are the steps for setting the virtual memory size (in Windows XP. See page 2-17 for Windows 2000):

  1- Click on Start | Settings | Control Panel | System

  2- Click on the Advanced Tab

  3- Click on the Settings button under the Performance group

4- Click on the Advanced tab

5- Click the Change button under Virtual Memory

6- Replace the initial and maximum values

7- Click Set then OK three times to exit to the main screen

- To speed up the study region aggregation process, state databases can be copied to the local hard-disk. If necessary, the Registry can be updated so that HAZUS-MH looks to the location where you copied the data on the local hard disk rather than to the default DVD location.

  The HAZUS-MH MR3 installation allows the user to specify the folder where the state data will be copied through the "Choose Data Path" dialog in the installation wizard. If, at the time of installation, the user specifies the folder where the data will be copied after installation, they only need to perform Step 1 as described below. If at the time of installation the User does not specify the folder where the state data will be copied by the user after installation, or if they want to change the folder specified during installation, then Steps 2 through 4 for updating the Registry should be completed.

  NOTE: The "Choose Data Path" dialog in the installation process only specifies the folder where the state data will be copied by the user from the DVD after installation has completed. This dialog doesn't copy the data from the DVD to the specified folder; that has to be done manually by the user after installation.

  1- Copy one or more of the state data folders (e.g., NC1), both the DVD identification files (e.g., D1.txt ^ 4.txt) and "syBoundary.mdb" from the Data DVD to a folder on your hard drive (e.g., D:\HAZUSData\). As an example, the following graphic illustrates how the data for the state of South Carolina would be organized under the HAZUS Data folder.

  2- Next, point the program to the data folder on your local hard drive. To do this, click the "Start" button and select "Run" to open the Run window, type "regedit" in the Run window edit box and click the "OK" button to open the Registry Editor. Navigate through the folders listed in the Registry Editor to the following location:

  HKEY_LOCAL MACHINE | SOFTWARE | FEMA | HAZUS-MH | General

  3- Now look at the right side of the window and find the entry called "DataPath1". Double click on "DataPath1" to open the Edit String window and enter the full name of the folder on the hard drive that contains the data copied from the DVDs in the edit box. Click the OK button to update the DataPath1 value.

IMPORTANT: Make sure the path ends with a "\" and do not change any of the other registry settings.

4- Close the Registry Editor by choosing Exit from the File menu of the Registry Editor.

Capabilities

- Transferring data, including importing study regions, from HAZUS99, HAZUS99-SR1, HAZUS99-SR2, HAZUS-MH and HAZUS-MH MR1 to HAZUS-MH MR3 will require the assistance of technical support.

- Except for Puerto Rico, inventory data are unavailable for the U.S. held territories.

- Due to lack of default data, Riverine users in the States of Hawaii and Alaska and Puerto Rico will be unable to perform hydrologic analyses. These users may still compute Riverine flood hazard; however, options of specific return period and suite of return periods will be unavailable. Instead specific discharge should be selected.

- Components of independently developed data sets in the default inventory data might not line up on maps, for example, the placement of bridges and roads, and facilities. This situation can be addressed by updating the default inventory data with user supplied data.

- When running the hydrology analysis the recommended limitation is 150 reaches to ensure function completion.

- When running the hydraulic (Delineate Floodplain) analysis, the recommended limitation is 24-reaches for the suite and 90-reaches for single discharge or single return period, assuming the machine has 2 GB of RAM.

- Running the General Building Stock analysis might require 1 to 3 hours analysis time.

- The flood date (Analysis -> Parameters -> Agricultural...) needs to be set before running the agricultural analysis (Analysis -> Run -> Agricultural Products). Failure to do so will result in a message during analysis that will require interaction and will likely delay completing the batch of selected analyses.

- The coastal What Ifs, Long-term Erosion and Shore Protection features are disabled.

BIT and InCAST

- In the Flood Model, BIT does not allow mapping from specific to general building types.

- Since InCAST development predated the development of the Flood Model in HAZUS-MH, data types used for different types of hazard specific data in InCAST are not compatible with those used in HAZUS-MH MR3. Additionally, InCAST does not capture all hazard specific attributes used in HAZUS-MH MR3.

InCAST can be used to capture flood hazard data which can be imported into HAZUS-MH MR3 from hzIncast table. However, the following fields should not be imported: BldgType, Kitchen, Dinning and Sleeping.

Technical Support

- Technical support is available via telephone, e-mail, or FAX. The numbers and addresses are listed on the HAZUS software package and under the Help menu in the software. Information on HAZUS updates, software patches, and FAQs are available at http://www.fema.gov/plan/prevent/hazus/index.shtm/.

What's New in HAZUS – Flood Model

Due to numerous changes in the hazard that impacts final results, it is recommended that users build and analyze new study regions rather than import existing study regions. The most important of these changes are shown below.

What's New in HAZUS-MH MR1

Data

- Updated valuations for the general building stock.

Methodology

- Optimized riverine and coastal flooding hazard characterization

Other Features

- Operation on the new ArcGIS 9.0 SP1 platform
- Improved integration with the underlying ArcGIS platform.
- Capability to run HAZUS-MH MR1 without administrative rights.
- Flood Information Tool (FIT) integrated into the HAZUS-MH MR1 installation.
- Capability to utilize third-party tools.

What's New in HAZUS-MH MR2

Data

- 2005 valuation data for all occupancy classes.
- Means location factors for residential and non-residential occupancies on a county basis.
- Updated and validated valuation data for single-family residential housing and manufactured housing based on comparisons with other national databases.
- Zeros substituted for any negative values calculated for the daytime, nighttime, working commercial, working industrial and commuting populations.
- Construction age and values by decade for every census block with floor area (square footage).

Methodology

- Capability to create study regions larger than four counties using the full version of SQL Server. (The 90,000 census block limit, which approximates four counties, is still applicable to study regions created with SQL Server MSDE with its 2 GB size limit.)

Other Features

- Keyboard operation of all user interface operations with some exceptions.
- Operation on the ArcView 9.1 SP1 platform.
- Certified on Windows XP SP2.
- Operation on the MDAC 2.8 data access engine from Microsoft.

What's New in HAZUS-MH MR3

Data

- Commercial data updated to Dun & Bradstreet 2006.
- Building valuations updated to R.S. Means 2006.
- Building counts based on census housing unit counts for RES1 (single-family dwellings) and RES2 (manufactured housing) instead of calculated building counts.

Methodology

- User-supplied flood maps and flood depth grids import into the "quick look" and "enhanced quick look" functions.
- Optimized building analysis.
- Revised hazard menu graphic user interface.

Other Features

- Operation on the ArcView 9.2 SP2 platform.
- Operation on Microsoft SQL Server 2005 Express.
- Operation on the MDAC 2.8 SP1 data access engine from Microsoft.
- Operation on FarPoint Spread 7 – Spreadsheet.
- Operation on Crystal Reports 11.
- Enhancements to the existing aggregation routines to reflect improved procedures for processing study region information.

CHAPTER 1 INTRODUCTION TO THE FLOOD LOSS ESTIMATION METHODOLOGY 1-1

1.1 Overview of the Methodology 1-1

1.2 Flood Hazards Considered in the Methodology 1-3

1.3 Types of Buildings and Facilities Considered 1-3

1.4 Levels of Analysis 1-4

1.5 Assumed Levels of Expertise of Users 1-8

1.6 When to Seek Help 1-8

1.7 Methodology Results 1-9

1.8 Uncertainties in Loss Estimation 1-11

1.9 Applications of the Results 1-11

1.10 Organization of the Manual 1-12

CHAPTER 2 INSTALLING AND STARTING HAZUS-MH MR3 2-1

2.1 System and Software Requirements 2-1

2.2 Installation 2-2

2.3 Upgrading from HAZUS99 to HAZUS-MH 2-9

2.4 Starting the Program 2-10

2.5 Uninstalling the Program 2-10

2.6 Program Basics 2-12

2.6.1 Menu Bar 2-12

2.6.2 Tool Bar 2-15

2.7 Limitations for Use for HAZUS-MH MR3 2-15

CHAPTER 3 RUNNING HAZUS FLOOD WITH DEFAULT DATA 3-1

3.1 Defining the Study Region 3-1

3.2 Examining Inventory Data 3-7

3.2.1 Inventory Menu Items 3-8

3.2.2 General Building Stock 3-8

3.2.3 Essential Facilities 3-20

3.2.4 High Potential Loss Facilities 3-21
3.2.5 User-Defined Facilities 3-22
3.2.6 Transportation Systems 3-23
3.2.7 Utility Systems 3-24
3.2.8 Hazardous Materials 3-25
3.2.9 Demographics 3-26
3.2.10 Agriculture Products 3-26
3.2.11 Vehicle Data 3-28
3.2.12 View Classification 3-30
3.2.13 Showing Tabular Data on Map 3-30
3.2.14 Printing Tabular Data 3-32

3.3 Defining the Flood Hazard 3-32
3.3.1 Selecting the Flood Hazard Type 3-33
3.3.2 Defining Topography 3-34
3.3.3 Download DEM Data from USGS 3-34
3.3.4 Incorporate DEM Data 3-43
3.3.5 Import Other User Data 3-46
3.3.6 Riverine 3-48
3.3.7 Coastal 3-61
3.3.8 Riverine and Coastal 3-74
3.3.9 Using Hazard What-Ifs 3-75
3.3.10 Using Quick Look 3-79
3.3.11 Using Enhanced Quick Look 3-80

3.4 Running an Analysis Using Default Data 3-81
3.4.1 Viewing Damage Functions 3-81
3.4.2 Viewing Restoration Functions 3-89
3.4.3 Setting Analysis Parameters 3-89
3.4.4 Flood Warning 3-97
3.4.5 Annualized Loss 3-99
3.4.6 Quick Look and Enhanced Quick Look 3-100
3.4.7 Running an Analysis 3-101

3.5 Viewing Analysis Results 3-103
3.5.1 Selecting a Case Study to View Results 3-103
3.5.2 View Tabular Results 3-104
3.5.3 View Mapped Results 3-105
3.5.4 Other Results 3-106

3.5.5 Print Reports 3-107

3.6 Default Databases 3-108

CHAPTER 4 DATA NEEDED FOR A MORE COMPLETE LOSS ESTIMATION STUDY..... 4-1

4.1 Developing an Inventory 4-1

4.1.1 Inventory Components 4-1

4.1.2 Approach 4-3

4.1.3 Classification Systems 4-4

4.2 Improving Flood Hazard Data 4-5

4.2.1 Riverine Capabilities 4-6

4.2.2 Coastal Capabilities 4-6

CHAPTER 5 UPDATING HAZUS INVENTORY DATA (COLLECTING DATA) 5-1

5.1 Sources of Information 5-1

5.1.1 General Building Stock 5-2

5.1.2 Occupancy to Building Type Relationships 5-5

5.1.3 Essential Facilities 5-5

5.1.4 Used-Defined Facilities 5-6

5.1.5 Demographics 5-6

5.1.6 Direct Economic Loss Parameters 5-6

5.2 Collecting Inventory Data 5-8

CHAPTER 6 UPDATING INVENTORY DATA: ENTERING AND MANAGING DATA..... 6-1

6.1 Importing Features and Files 6-1

6.1.1 Importing Site-Specific Data Files 6-1

6.1.2 The Import Database Utility 6-3

6.1.3 Pre-processing Inventory Point Data 6-5

6.2 Adding Records to Site Specific Databases 6-10

6.2.1 Adding Features Using the Study Region Map 6-11

6.2.2 Adding Records to the Attribute Table 6-13

6.2.3 Errors When Adding Records 6-14

6.3 Deleting Records from Site Specific Databases 6-14

6.4 Editing Records 6-15

6.5 Adding Lifeline Segments 6-15

CHAPTER 7 MODIFYING INVENTORY DATA 7-1

7.1 Modifying General Building Stock Data 7-1
7.1.1 Building Square Footage, Count and Occupancy Category 7-1
7.1.2 Building Financial Data 7-1
7.1.3 Edit General Building Stock (GBS) Tables 7-2
7.1.4 Import Data File 7-2
7.1.5 General Occupancy Mapping 7-2
7.1.6 Flood Specific Occupancy Mapping 7-5
7.2 Modifying Facilities, Lifeline and Hazardous Materials Data 7-8
7.2.1 Edit Facilities, Lifeline and Hazardous Materials Tables 7-8
7.2.2 Importing Site Specific Data through Open Database Connectivity (ODBC) 7-10
7.2.3 Import Data File to HAZUS 7-20

CHAPTER 8 BUILDING DATA IMPORT TOOL 8-1

8.1 Getting Your Data in the Right Format 8-1
8.2 Starting BIT 8-1
8.3 Specifying the Input File 8-2
8.3.1 Importing an ASCII Delimited Database 8-2
8.3.2 Importing a *.mdb Database 8-5
8.4 Mapping Fields 8-5
8.5 Categorizing Data 8-10
8.5.1 Categorizing Number of Stories Data 8-11
8.5.2 Categorizing Year Built Data 8-12
8.5.3 Categorizing Occupancy Class Data 8-13
8.5.4 Categorizing Building Type Data 8-15
8.5.5 Categorizing Design Level (Optional) 8-17
8.5.6 Categorizing Floor Area 8-19
8.5.7 Categorizing Building Value 8-19
8.5.8 Categorizing Content Values 8-20
8.6 Aggregating the Database Statistics 8-20
8.7 BIT-MH Results 8-21

CHAPTER 9 OVERVIEW OF THE FLOOD INFORMATION TOOL (FIT) PROCESS……..9-1

9.1 Riverine Methodology 9-1
9.1.1 Input Floodplain Boundary 9-1
9.1.2 Centerline of Flow 9-1
9.1.3 Bounding Polygon 9-1
9.1.4 Non-Conveyance Areas 9-2
9.1.5 Interpolation of Additional Hazard Grids 9-2
9.1.6 Modeling Tips 9-2
9.2 Coastal Methodology 9-2
9.2.1 Shoreline Characterization 9-2
9.2.2 Frontal Dune Erosion 9-3
9.2.3 Output Hazard Grids 9-3

CHAPTER 10 RUNNING HAZUS FLOOD WITH USER SUPPLIED DATA 10-1

10.1 Defining the Study Region 10-1
10.2 Defining the Inventory Data 10-1
10.3 Defining the Hazard 10-1
10.4 Damage Functions 10-2
10.5 Restoration Time 10-4
10.6 Analysis Parameters 10-5
10.6.1 Debris Parameters 10-6
10.6.2 Casualties Parameters 10-7
10.6.3 Shelter Parameters 10-7
10.6.4 Agricultural Parameters 10-8
10.6.5 Direct Economic Loss Parameters 10-9
10.6.6 Indirect Economic Loss Module with a Synthetic Economy 10-9
10.6.7 Running the Indirect Economic Loss Module with IMPLAN Data 10-14

CHAPTER 11 VIEWING AND REPORTING THE RESULTS 11-1

11.1 Guidance for Reporting Loss Results 11-1
11.2 Hazard Results 11-2
11.3 General Building Stock 11-3

11.4 Essential Facilities 11-4

11.5 User-Defined Facilities 11-5

11.6 Debris 11-5

11.7 Shelter 11-6

11.8 Buildings Economic Loss 11-7

11.9 Summary Reports 11-8

CHAPTER 12 REFERENCES 12-1

Appendices

A. Verifying HAZUS Installation

B. Flood Specific Building Classification System

C. Using HAZUS for Specific Policy Applications

D. Flood Specific Table Data Dictionary

E. GIS Data Dictionary

F. ALOHA / MARPLOT Integration with HAZUS

G. FLDWAV / FLOODVIEW Integration with HAZUS

H. Running HAZUS with SQL Server 2005

Chapter 1 Introduction to the Flood Loss Estimation Methodology

1.1 Overview of the Methodology

HAZUS provides nationally applicable, standardized methodologies for estimating potential wind, flood, and earthquake losses on a regional basis. **HAZUS** can be used to conduct loss estimation for floods and earthquakes, and contains a preview model for hurricane loss estimation. The multi-hazard **HAZUS** is intended for use by local, state, regional officials, and consultants to assist mitigation planning and emergency response and recovery preparedness. For some hazards, **HAZUS** can also be used to prepare real-time estimates of damages during or following a disaster.

The **HAZUS** Flood Model is for floodplain managers, their contractors, and others who are responsible for protecting citizens and property from the damaging affects of flooding. It is an integrated system for identifying and quantifying flood risks based on state-of-the-art analysis. It provides an analytic, decision support tool to help communities make informed decisions regarding land use within their flood prone areas.

An overall schematic of the **HAZUS** Flood Model methodology is presented in Figure 1.1.

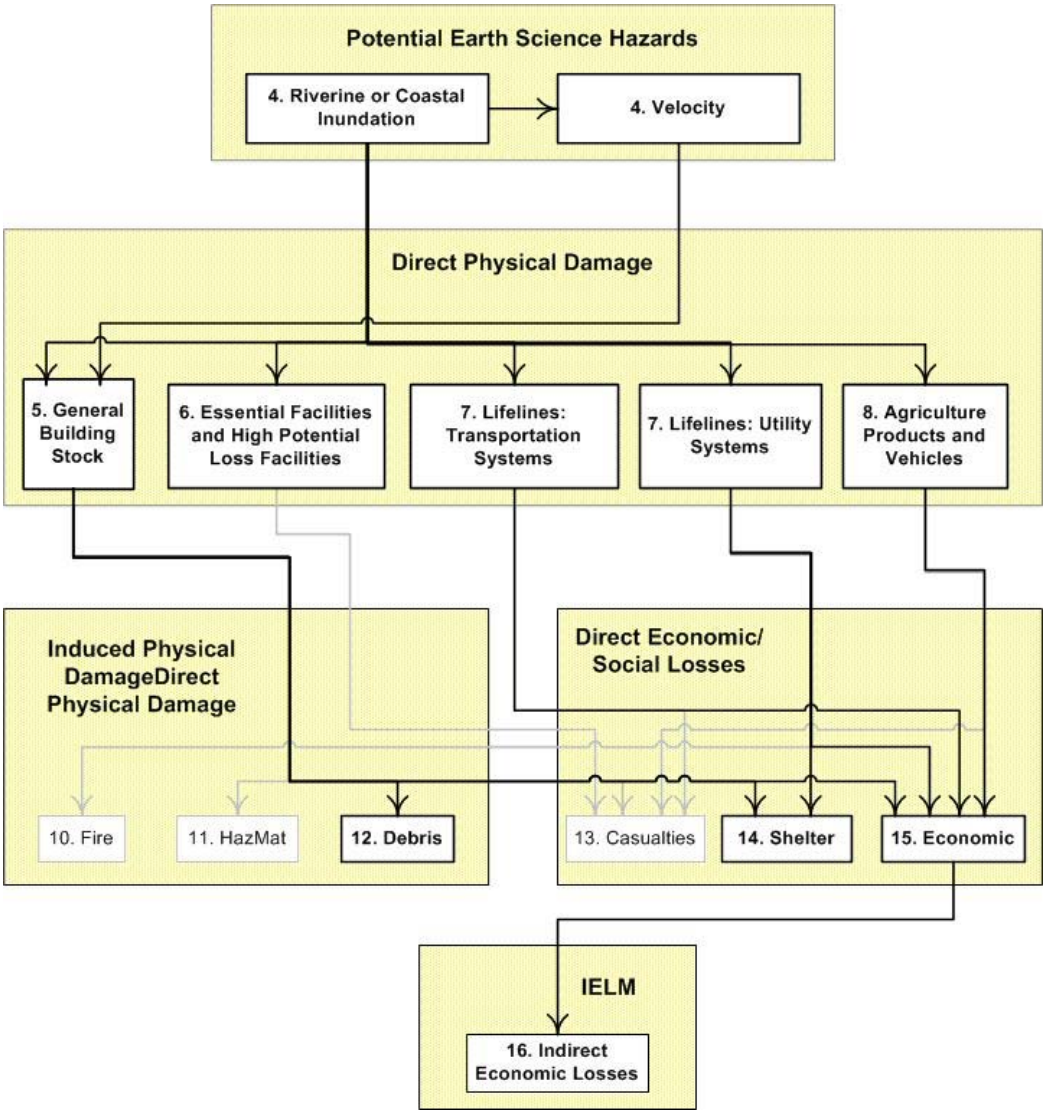


Figure 1.1 Flood Model Schematic

As shown in this figure, the Flood Model methodology consists of two basic analytical processes: Potential Earth Science Hazards, in this case the flood hazard analysis, and damage analysis, in this case the flood loss estimation analysis. In the hazard analysis phase, characteristics such as frequency, discharge, and ground elevation are used to model the spatial variation in flood depth and velocity. During the loss estimation phase, structural and economic damage is calculated based on the results of the hazard analysis through the use of vulnerability curves. Model results can then be conveyed to the user via a series of reports and maps.

The **HAZUS** software requires ArcGIS 9.2 to run and the flood model requires the associated spatial analyst extension. After study region aggregation, the program runs efficiently on a desktop computer. This manual gives detailed instructions for using the **HAZUS** program, but assumes that users have some proficiency with Geographic Information Systems (GIS) software.

1.2 Flood Hazards Considered in the Methodology

The **HAZUS** Flood Model analyzes both Riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth.

Depth, duration and velocity of water in the floodplain are the primary factors contributing to flood losses. Other hazards associated with flooding that contribute to flood losses include channel erosion and migration, sediment deposition, bridge scour and the impact of flood-born debris. The **HAZUS** Flood Model allows users to estimate flood losses due to depth of flooding although Level 1 users can develop order of magnitude losses due to flood velocity to the general building stock (GBS). The agriculture component will allow the user to estimate a range of losses to account for flood duration. The flood model does not estimate the losses due to high velocity flash floods at this time.

Flood warning is one offsetting component to the primary flood damage factors identified above. The flood model allows the user to perform "what-if?" analyses to identify what percentage of losses avoided may make a warning system beneficial. This methodology follows the U.S. Army Corps of Engineers approach using the "Day" curves.

In different contexts, flood hazard may have different meanings. Hazard can mean risk in some contexts and it can mean a source of danger in others. The hazard may be that an area is inundated about once every 10 years (risk) or it may be that an area is subject to flood depths ranging from 5 to 10 feet (source of danger). Flood frequency studies combine these ideas and define flood hazard in terms of the chance that a certain magnitude of flooding is exceeded in any given year.

Flood magnitude is usually measured as a discharge value, flood elevation, or depth. For example one may refer to the 100-year flood elevation. It is the elevation, at the point of interest, that has a one percent (1%) annual chance of being exceeded by floodwater. Using the flood frequency convention, flood hazard is defined by a relation between depth of flooding and the annual chance of inundation greater than that depth. The relation is called a depth-frequency curve.

1.3 Types of Buildings and Facilities Considered

An important requirement for estimating losses from floods is the identification and valuation of the building stock, infrastructure, and population exposed to flood hazard (i.e., an inventory.) Consequently, the **HAZUS** Flood Model uses a comprehensive inventory in estimating losses. This inventory serves as the default when a user does not have better data available. The inventory consists of a proxy for the general building stock in the continental United States. Additionally, the model contains national data for essential facilities (e.g., police stations), high potential loss facilities (e.g., dams), selected transportation (e.g., highway bridges) and lifeline systems (e.g., potable water treatment plants), demographics, agriculture products (e.g., corn), and vehicles. This inventory is used to estimate damage (%), and the direct economic losses for some elements (i.e., the general building stock) or the associated impact to functionality for essential facilities.

The Earthquake Model's general building stock is currently available at the census tract level, but increased resolution is needed to support the Flood Model. The census block was chosen as the level of aggregation due to its relatively small geographic size and the capability of the census to identify data at that level of detail. As the census data only provides sufficient information for the development of the residential structures data, Dun & Bradstreet (D&B) provided data for non-residential structures at the census block level.

1.4 Levels of Analysis

The Flood Model is designed for three levels of analysis:

Level 1 This is the simplest type of analysis requiring minimum effort by the user. It is based primarily on data provided with the software (e.g., census information, broad regional patterns of foundation distributions and no floodplain code adoption, etc.). The user is not expected to have extensive technical knowledge. While the methods require some user supplied input to run, the type of input required could be gathered by contacting government agencies or by referring to published information. At this level, estimates will be crude and will be appropriate as initial loss estimates to determine where detailed analyses are warranted.

Some components of the methodology cannot be performed in a Default Data Analysis since they require more detailed inventory than that provided with the methodology. The following are not included in the Default Data Analysis: damage/loss due to ground failure or erosion (riverine only), damage/loss due to earthquake driven flooding such as tsunamis or seiche, damage/loss due to dam failure. At this level, the user has the option (not required) to enter information about their own local facilities in lieu of using the default point facilities (e.g., essential facilities). The user also has the option to replace the general building stock utilizing tools provided with **HAZUS**. One week to one month would be required to collect relevant information depending on the size of the region and the level of detail the user desires.

Level 2 analysis improves level 1 results by considering additional data that are readily available or can be easily converted or computed to meet methodology requirements. In Level 2, the user may need to determine parameters from published reports or maps as input to the model. It requires more extensive inventory data and effort by the user than the Default Data Analysis. The purpose of this type of analysis is to provide the user with the best estimates of flood damage/loss that can be obtained using the standardized methods of analysis included in the methodology. Flood Model users will be required to use the Flood Information Tool (FIT) to pre-process their flood hazard data for use in the Flood Model. This is to ensure consistency in their local data and format the data to be read by the Flood Model. It is likely that the user will need to employ consultants to assist in the implementation of certain methods. For example, knowledgeable users of hydrology and hydraulics models are required to define flood elevations.

All components of the methodology can be performed at this level, with the exception of the velocity analysis, and the best results would be based on locally (user) developed inventories. As the user provides more complete data, the quality of the analysis and results improve. Depending on the size of the region and the level of detail desired by the user, one to six months would be required to obtain the required input for this type of analysis.

Level 3 analyses require extensive efforts by the user in developing information on the flood hazard and the measure of exposure. This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology. At this level, one or more technical experts are required to acquire data, perform detailed analyses, assess damage/loss, and assist the user in gathering extensive inventory data. It is anticipated that at this level there will be extensive participation by local utilities and owners of special facilities. There is no standardized Advanced Data and Models Analysis study. The quality and detail of the results depend upon the level of effort. Six months to two years would be required to complete an Advanced Data and Models Analysis. Each subsequent level builds on and adds to the data and analysis procedures available in previous levels.

Figure 1.2 provides a graphic representation of the various levels of analysis and the subsequent user sophistication to achieve that level of analysis.

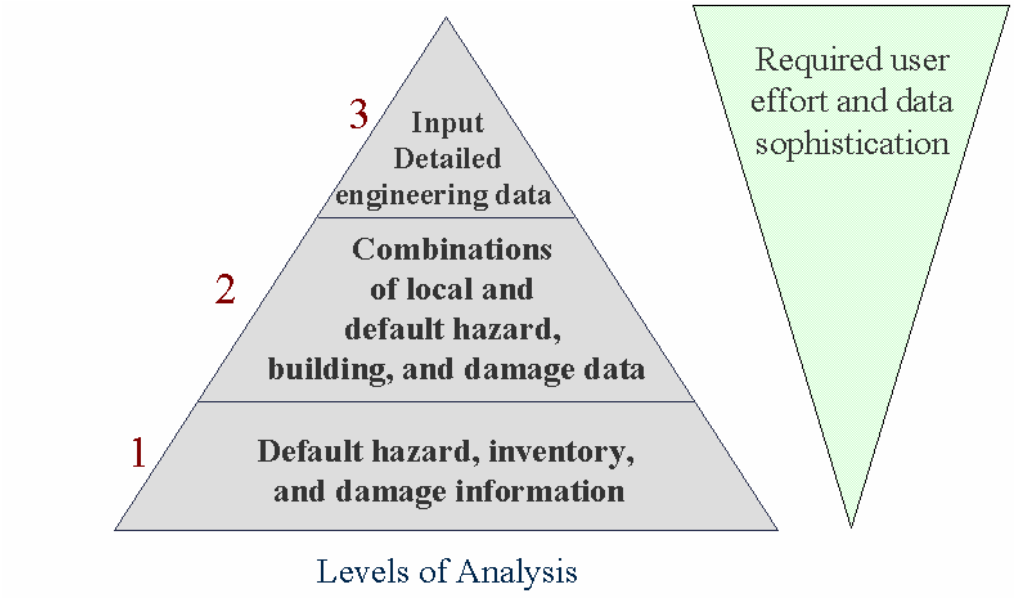


Figure 1.2 Levels of Analysis and User Sophistication

The attributes of the model for each level of analysis and examples of typical applications are presented in Table 1.1.

Table 1.1 Attributes of the *HAZUS* Flood Model

	Level 1	Level 2	Level 3
Hazard	User supplied Digital Terrain or Elevation Model (DEM), typically the USGS 30-meter DEM. The Flood Model will use default hazard data including Hydrologic Unit Codes, and accumulation methodology to develop approximate stream centerlines. USGS regression equations and gage records will be used to determine discharge frequency curves.	User supplied flood stream cross-sections attributed with elevations, or lines of Base Flood Elevation (BFE). Coastal users will supply polygons attributed with the BFE. A flood boundary of some form is required. User supplied hazard data pre-processed via the FIT. DEM consistent with their FIT data	Similar to Level 2 although the user will likely work with Hydraulic models outside of the flood model and the FIT. User will be required to pre-process the data through the FIT.
Inventory	HAZUS default data. Allocation of census block data via statistical analysis, and broad assumptions for first floor height based on foundation distributions. Agriculture products, vehicles, essential facilities, some transportation and utility facilities	User supplied inventory data such as Tax Assessor data processed through the Building Inventory Tool (BIT) (Census Block aggregation). Inventory data developed via site surveys through the Inventory Collection Tool (InCAST) (site specific analysis). Users enhance the first floor height and other parameters.	High quality data re: building values, flood vulnerabilities, contents, occupancies, etc, extended to industrial and other high-value facilities.
Damage Curves	Broad regional default curves based on available FIA or USACE depth damage curves. Library of curves available for user selection. User may create their own function using library curves as guides.	User specifically modifies the existing curve library for local practices.	User-input curves based on detailed building surveys, specific crop conditions etc.
Damage Estimation	Area weighted damage estimates based on the depth of flooding within a given census block. Losses developed for general building stock, essential facilities, vehicles, agricultural products, select transportation and utility features.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.
Direct Loss/ Impacts	Cost of repair / replacement, shelter needs, temporary housing, vehicles, crop & livestock losses.	Consistent with Level 1,estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves.

Table 1.1 Attributes of the *HAZUS* Flood Model

	Level 1	Level 2	Level 3
Induced Losses	Debris developed from direct damage to buildings based on floor areas from the general building stock.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves. Site specific debris generation currently not available in the flood model, must be based on census block attribution of floor area.	Consistent with Level 1, estimation enhanced by improved hazard data and detail in inventory data and modification to damage curves. Site specific debris generation currently not available in the flood model, must be based on census block attribution of floor area.
Indirect Loss/ Impacts	Sectoral economic impacts.	Sectoral economic impacts.	Sectoral economic impacts.
Typical Applications	• Flood mitigation / regulatory policy-making, regional, state, federal levels • Pre-feasibility studies • Real-time emergency response with no warning • Preliminary planning, zoning development	• Planning, zoning, development • Selecting mitigation alternatives • Pre-feasibility engineering studies • Emergency planning and real-time response • Environmental impact analysis • Education	• Analysis for essential, cultural, high-loss potential facilities • Emergency planning and real-time response • Mitigation and engineering research • Scientific research

1.5 Assumed Levels of Expertise of Users

Flood model users can be broken into two groups: those who perform the analysis, and those who use the results. For some efforts these two groups will consist of the same people, but generally this will not be the case. However, the more interaction that occurs between these two groups, the better the analysis will be. End users of the loss estimation analysis need to be involved from the beginning to make results more usable.

Those who performed the flood model analysis must, at a minimum, have a basic understanding of flood risk issues. Even Level 1 users will be prompted to enter appropriate community specific information, such as the drainage area the model should use when generating the stream network, or the 100-year Still Water Elevation (SWEL) when performing a coastal analysis. In many cases, the results will be presented to audiences (i.e., city councils and other governing bodies) that have little technical knowledge of the flood loss problem.

To obtain the best results, it is assumed that the loss analysis will be performed by a team consisting of floodplain manager(s), structural engineer(s), economist(s), sociologist(s), hydrologist(s), emergency planner(s), public works personnel, and the loss estimate users. These individuals are needed to develop flood return periods or discharges of interest or concern, develop and classify building inventories, provide and interpret economic data, provide information about the local population, and to provide guidance on what loss estimates are needed to fulfill the user's goals. The participation of at least one GIS specialist with some level of familiarity or expertise in data management and GIS would be very beneficial.

If a local or state agency is performing the analysis, some of the expertise can be found in-house. Experts are generally found in several departments: building permits, public works, planning, public health, engineering, information technologies, finance, historical preservation, natural resources, and land records. Although internal expertise may be most readily available, participation of individuals from academic institutions, citizen organizations, and private industry cannot be underestimated.

1.6 When to Seek Help

The results of a loss estimation analysis should be interpreted with caution. If using the Level 1 methodology with default data, there will be a great deal of uncertainty associated with the loss estimate. If the loss estimation team does not include individuals with expertise in the areas described above, then it is likely that one or more outside consultants may be required to assist with interpreting the results. It is also advisable to retain objective reviewers with subject expertise to evaluate and comment on map and tabular data outputs.

A consultant familiar with hydrology and hydraulics (H&H) will understand the basis of the methodology and can provide a great deal of input on the utilization of output results. Attention should be given to any differences in the methodology used to define documented scenarios. A scenario event that is defined without an in-depth understanding of the flood sources and built environment may not be appropriate for the loss estimation analysis.

If the user intends to modify the default inventory data or parameters, assistance will be required from an individual with expertise in the subject. For example, if the user wishes to change default percentages of model foundation types for the region, a structural engineer with knowledge of regional design and construction practices will be helpful. Similarly, if depth-damage relationships or other curves selected from the damage function library need editing, input from a structural engineer is recommended. Modifications to defaults in the direct and indirect economic modules require input from an economist.

NIBS has established technical help for **HAZUS** users. Users should contact FEMA or NIBS at the email, phone, fax, or addresses provided in this manual. For information on technical support users, agency and organizational websites are also listed in this report to access Frequently Asked Questions (FAQs), software updates, training opportunities, and User Group activities.

1.7 Methodology Results

There is a great deal of flexibility in displaying output. Tables of social and economic losses can be displayed on the screen, printed, or pasted into electronic documents. Most outputs can also be mapped. Colors, legends and titles can be easily altered. Results can be compiled to create electronic presentations, or as inserts to a community project report.

Examples of graphical and numerical outputs that can be produced by the program are found in Figure 1.3 and Figure 1.4.

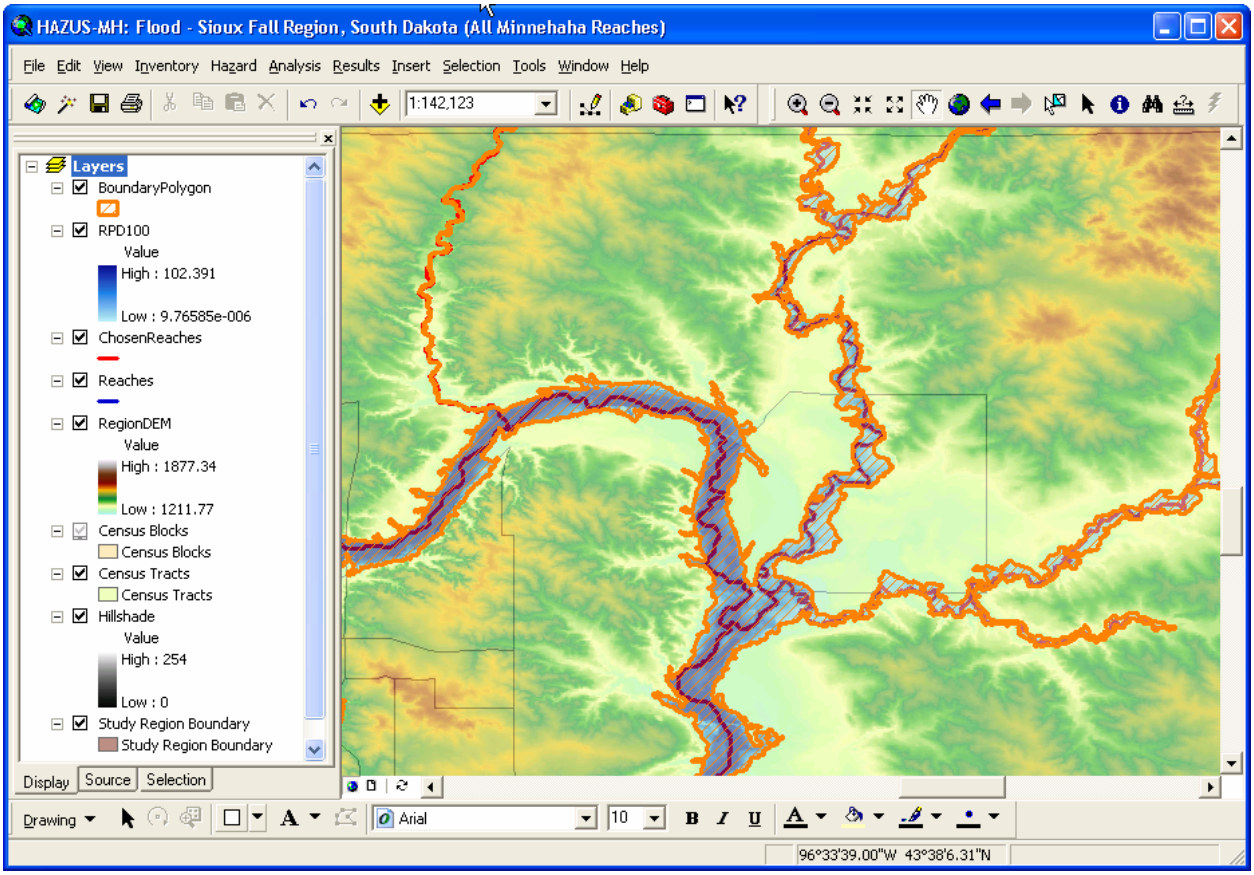


Figure 1.3 Sample Graphic Output Flood Depth Grid for A 100-year Flood

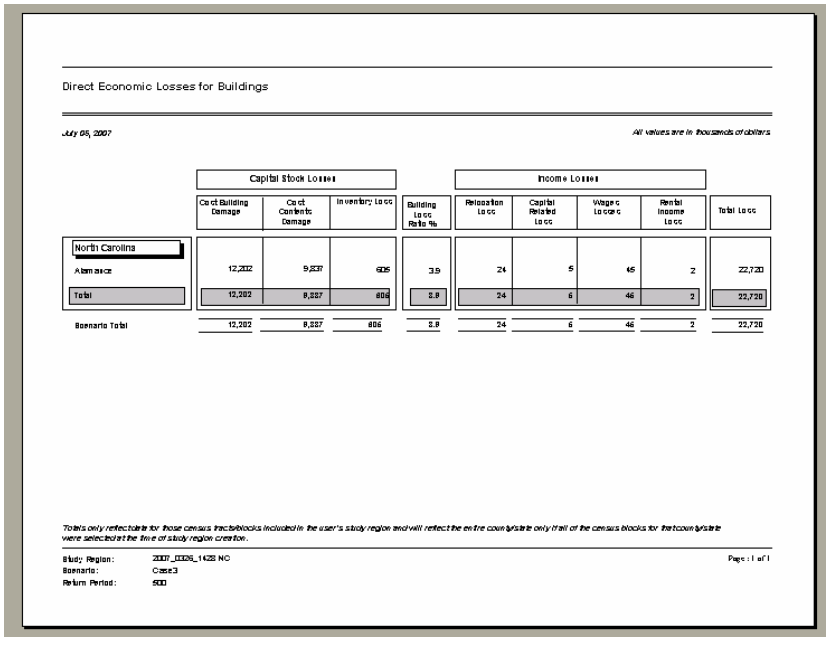


Figure 1.4 Sample Numerical (Crystal Report) Output

1.8 Uncertainties in Loss Estimation

The user should always be aware that numbers produced by software models such as **HAZUS** are to be used with a certain degree of caution. Uncertainty within the results can be introduced from a number of sources including the use of national datasets to represent local conditions, simplifications within the model introduced to allow the model to have flexibility with Level 1 users, and errors introduced as part of the mathematical processing within the software code. Finally, user input can also have a great affect on the uncertainty associated with the results. At this time, the flood model does not provide the user with an assessment or "treatment" of uncertainty. As a planning tool, the consistency and value of the results developed by **HAZUS** cannot be understated. When properly used, the results developed by **HAZUS** can allow a user to identify and manage the flood hazard especially as it relates to development trends and the management of fiscal resources.

1.9 Applications of the Results

Figure 1.5 summarizes the output that can be obtained from an analysis. There is a great deal of flexibility in displaying output. Tables of social and economic losses can be displayed on the screen, printed out or pasted into electronic documents. Most outputs can also be mapped. Colors, legends and titles can be altered easily. Details are provided in Chapter 10.

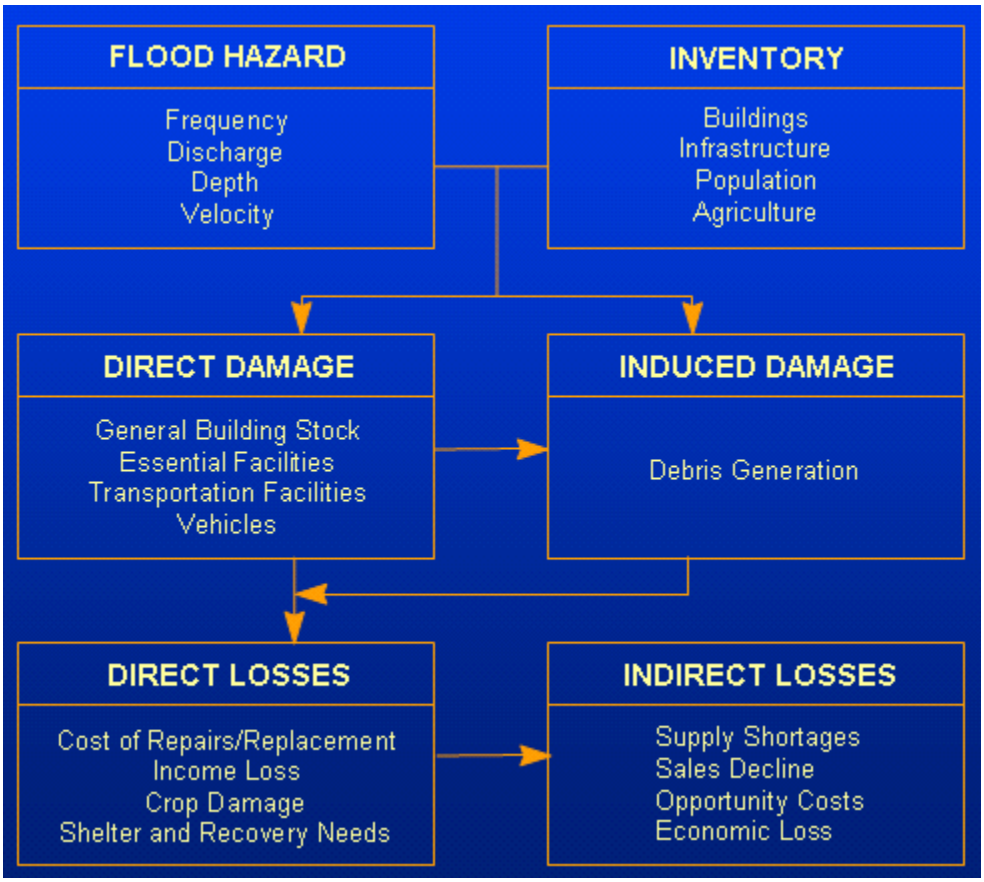


Figure 1.5 Sample Numerical (Crystal Report) Output

1.10 Organization of the Manual

The *User Manual* provides the background and instructions for developing an inventory to complete a flood loss estimation study using **HAZUS**. It also provides information on how to install and run the software, and how to interpret and report model output. The contents and organization of the User Manual are outlined below.

The Technical Manual accompanies this publication. It documents the default data and explains the methodology used to calculate flood related losses. Together, the two manuals provide a comprehensive overview of the nationally applicable loss estimation methodology.

Chapter 1: Provides the user with a general understanding of the purpose, uses and components of a regional flood loss estimation analysis.

Chapter 2: Gives instructions for installing, starting, and installation verification of **HAZUS**.

Chapter 3: Provides an analysis using only default data.

Chapter 4: Provides an overview of the types of data required to run the loss analysis, as well as a description of the default databases.

Chapter 5: Contains detailed information about what data are needed to complete a loss study, sources of inventory, how to collect inventory, and related expenses to anticipate. This chapter also describes how to convert data to the correct format for the methodology, and how to enter data into **HAZUS**.

Chapter 6: Includes instructions for entering data, editing records and geocoding addresses.

Chapter 7: Provides the user with a discussion on how to display, modify and print databases.

Chapter 8: Discusses the Building Data Import Tool (BIT). This utility is designed to help the user analyze and query existing databases to develop general building stock inventory information.

Chapter 9: Discusses the Flood Information Tool (FIT) briefly. This ArcGIS extension is designed to process user-supplied flood hazard data into the format required by the HAZUS Flood Model.

Chapter 10: Provides a detailed step-by-step description of how to run an analysis using **HAZUS**, including analysis with user-supplied data.

Chapter 11: Discusses how to view results and provides suggestions on how to develop a report.

Chapter 12: References.

The *User Manual* is written in language that should be easily understood by a user of the methodology. Highly technical terms are avoided where possible, but a glossary of terms is provided in Appendix H to supplement any definitions that are needed. A compilation of relevant references is found in the References Section.

The appendices contain detailed information about the structure of the methodology.

Appendix A: Installation verification provides a quick start tutorial for the **HAZUS** Flood Model.

Appendix B: Provide descriptions of the model building types that are used in the methodology.

Appendix C: Provides the user with examples of using the **HAZUS** Flood Model to support policy decisions and other flood-related applications. The chapter also provides a complete explanation of the "what if?" capabilities of the flood model.

Appendix D	Database dictionary containing details about the format of the **HAZUS** databases.
Appendix E	GIS Data Dictionary containing metadata regarding GIS datasets used as input in the flood hazard computations.
Appendix F	ALOHA / MARPLOT Integration with HAZUS
Appendix G	FLDWAV / FLOODVIEW Integration with HAZUS
Appendix H	Running HAZUS with SQL Server 2005

Chapter 2 Installing and Starting HAZUS-MH MR3

2.1 System and Software Requirements

In order for HAZUS to run properly, your system must meet certain minimum requirements. Table 2.1 Hardware and Software Requirements for HAZUS provides guidance for three software operation levels. System requirements are directly related to the volume of data to be used in the analysis. For example, reasonable processing times can be expected when using the "Recommended" computer system if the software operator is analyzing multiple earthquake scenarios for large cities (population > 500,000). The operator is assumed to be working on an Intel PC.

Table 2.1 Hardware and Software Requirements for HAZUS-MH MR3

	Minimal	Moderate	Recommended
Computer Speed Memory	Pentium® III 1 GHz core speed and 512 MB RAM Note: Allows moderately fast analysis of small communities only	Pentium® 4 2 GHz core speed and 512 MB RAM Note: Allows fast analysis of medium-sized communities and real-time analysis for small communities	Pentium® 4 with 800 MHz system bus and 2.6 GHz (or better) core speed and 1 GB RAM Note: Allows fast analysis of large urban areas and real-time analysis for all communities
Computer Storage: Free Hard Disk Space	10 GB Note: Allows installation of **HAZUS** and storage of three scenarios for a medium-sized community	40 GB Note: Allows installation of **HAZUS** and storage of three scenarios for large urban areas	80 GB Note: Allows installation of **HAZUS** and storage of 25 or more scenarios for large urban areas
Hardware Accessories	CD-ROM reader with 32x minimum read speed DVD-ROM reader with 12x minimum read speed Graphics Card with 800x600 minimum resolution Mouse, Keyboard and 19" Monitor		

	Minimal	Moderate	Recommended
Supporting Software	Microsoft Windows 2000 SP2 SP3 and SP4 (and Microsoft Windows XP SP1 (English Versions) ArcView 9.2 SP2 Spatial Analyst extension required with flood model. • HAZUS installation will allow user to install HAZUS on MS Windows 2000 and XP Service Packs higher than SP4 and SP1 respectively, but HAZUS is not certified to work flawlessly with those service packs. • For specific directions about using HAZUS with Windows XP SP2 please refer to the document DirectionsForUsingHazus-MH_With_WinXP_SP2.doc on the installation DVD or HAZUS-MH installation folder.		

ArcGIS can be purchased by contacting ESRI, Incorporated at 1-800-447-9778, or online at http://www.esri.com. ArcGIS and Windows products should be installed using the manufacturer's instructions.

Internet access is highly recommended, although not a system and software requirement. The **HAZUS** operator may occasionally need to access online Help, and current program status reports.

2.2 Installation

Before installing **HAZUS**, the minimum requirements listed in Section 2.1 should be met. If you are upgrading from HAZUS-99, read the section at the end of this chapter entitled "Upgrading from HAZUS-99 to **HAZUS-MH**".

To install **HAZUS**, follow the steps outlined below.

1. Start Windows and log in with an account with Administrator rights.
2. Insert "**HAZUS** Setup" DVD in your **DVD-ROM drive**. The setup will launch automatically.
3. If the setup does not launch automatically follow steps (4 and 5).

4. From the Windows **Start** menu select **Run...**. The following screen will appear.

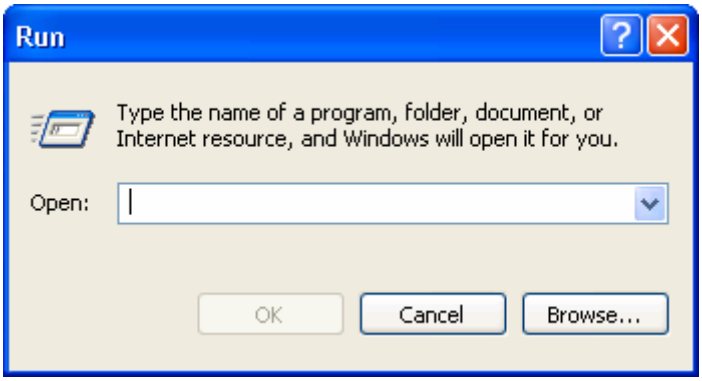


Figure 2.1 Run Command Dialog Box

5. To start the **HAZUS** setup program type ***x*:\setup** in the command line box as shown in Figure 2.1, where ***x*** is the DVD-ROM drive letter. Press Enter or click the **OK** key.

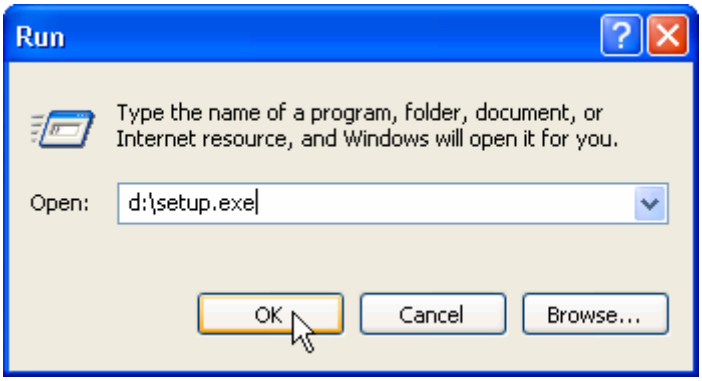


Figure 2.2 Start the HAZUS Setup Program

6. The setup program will appear. Click on the **Next** button.

Figure 2.3 Start of the HAZUS Installation Program

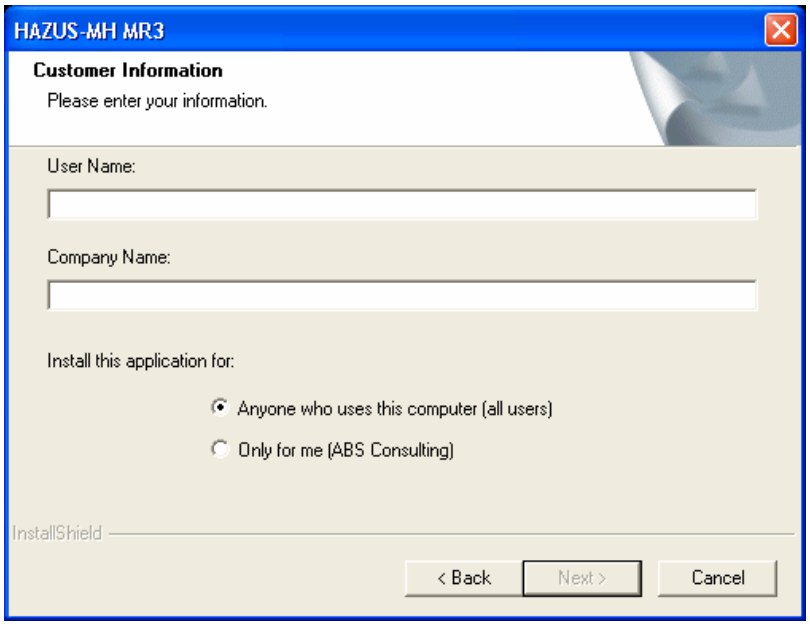


Figure 2.4 Register User Name and Program Permissions

7. Permit program access to anyone who uses the computer or exclude others from accessing **HAZUS** program and data. Enter your User Name and Company (or Agency) information. Select the appropriate installation choice for your study project. Then, click on the **Next** button.

8. Select the preferred type of installation shown in Figure 2.5 and Figure 2.6. Install the complete set of **HAZUS** modules (3 hazard modules, BIT, InCAST and FIT tools), the compact set (3 hazards, no tools), or select to customize your installation from one or more hazard and tool modules. Click on the **Next** button.

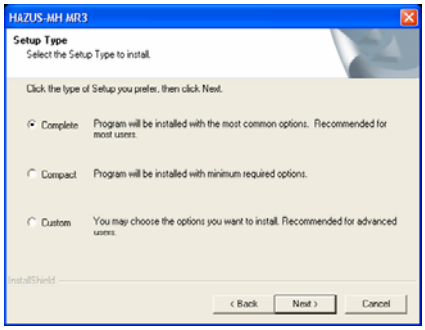

HAZUS-MH MR3
Setup Type
Select the Setup Type to install.
Click the type of Setup you prefer, then click Next.
Complete
Program will be installed with the most common options. Recommended for most users.
Compact
Program will be installed with minimum required options.
Custom
You may choose the options you want to install. Recommended for advanced users.
InstallShield
< Back
Next >
Cancel

Figure 2.5 Complete Installation

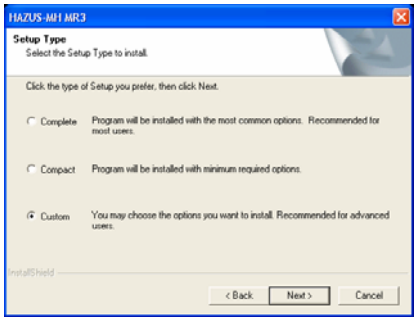

HAZUS-MH MR3
Setup Type
Select the Setup Type to install.
Click the type of Setup you prefer, then click Next.
Complete
Program will be installed with the most common options. Recommended for most users.
Compact
Program will be installed with minimum required options.
Custom
You may choose the options you want to install. Recommended for advanced users.
InstallShield
< Back
Next >
Cancel

Figure 2.6 Custom Installation

9. Specify the directory where you wish **HAZUS** to be installed. The default directory is C:\Program files**HAZUS-MH**, as shown in Figure 2.7. If you accept the default destination directory, click on the **Next** button.

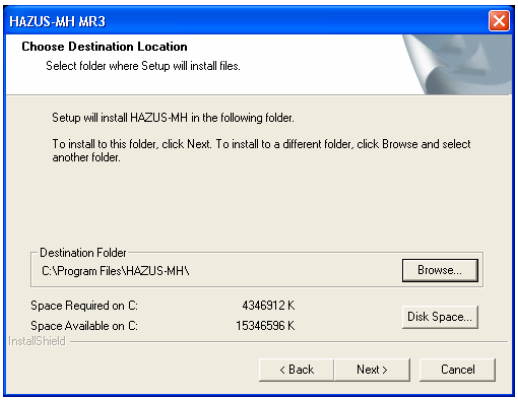

HAZUS-MH MR3
Choose Destination Location
Select folder where Setup will install files.
Setup will install HAZUS-MH in the following folder.
To install to this folder, click Next. To install to a different folder, click Browse and select another folder.
Destination Folder
C:\Program Files\HAZUS-MH\
Browse...
Space Required on C:
4346912 K
Space Available on C:
15346596 K
Disk Space...
InstallShield
< Back
Next >
Cancel

Figure 2.7 Specify the Path of the HAZUS Program Directory

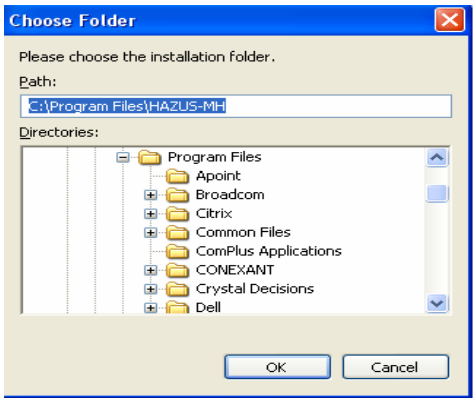


Figure 2.8 Specify the Path of the HAZUS Directory Interactively

Otherwise click on the **Browse** button and interactively choose a directory. The window will appear as shown in Figure 2.8.

You can select or type-in a new directory path and click on **OK**. You will be returned to the original "Select Installation Directory" window and the directory that you have selected will appear in the middle of the window. Click the **Next** button.

10. Folders will be created for the data files associated with your study regions. Specify the primary destination directory where you prefer HAZUS Region subfolders to be created. The default directory is C:\Program Files\HAZUS-MH, as shown in Figure 2.9. If you accept the default destination directory, click on the **Next** button. Otherwise, click on the Browse button and interactively choose a directory. The "Select Destination Directory" will appear as shown in Figure 2.10.

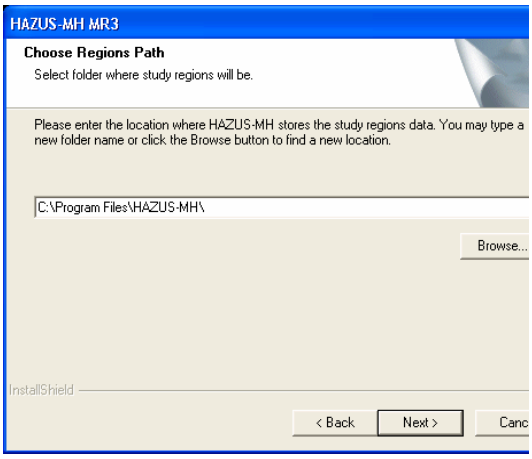

HAZUS-MH MR3
Choose Regions Path
Select folder where study regions will be.
Please enter the location where HAZUS-MH stores the study regions data. You may type a new folder name or click the Browse button to find a new location.
C:\Program Files\HAZUS-MH\
Browse...
InstallShield
< Back
Next >
Canc

Figure 2.9 Default Directory for Study Region Files

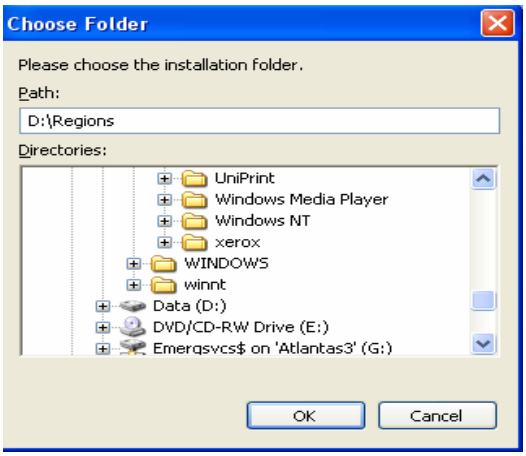


Figure 2.10 Create Directory for Study Region Files

11. By default the DVD Drive is assumed to be the folder where the state data will be available for running HAZUS. If you want to use the State Data from a Network or Local drive then click on the Browse button as shown in Figure 2.11 below and select the folder where you would like to copy the State Data after installation. If you want to use the state data from the DVD then there is no need to make a change to the path on the dialog. Click on the next button.

NOTE: The "Choose Data Path" dialog only specifies the folder where the state data will be copied by the user from the DVD after installation has completed. This dialog doesn't copy the data from the DVD to the specified folder; that has to be done manually by the user after installation.

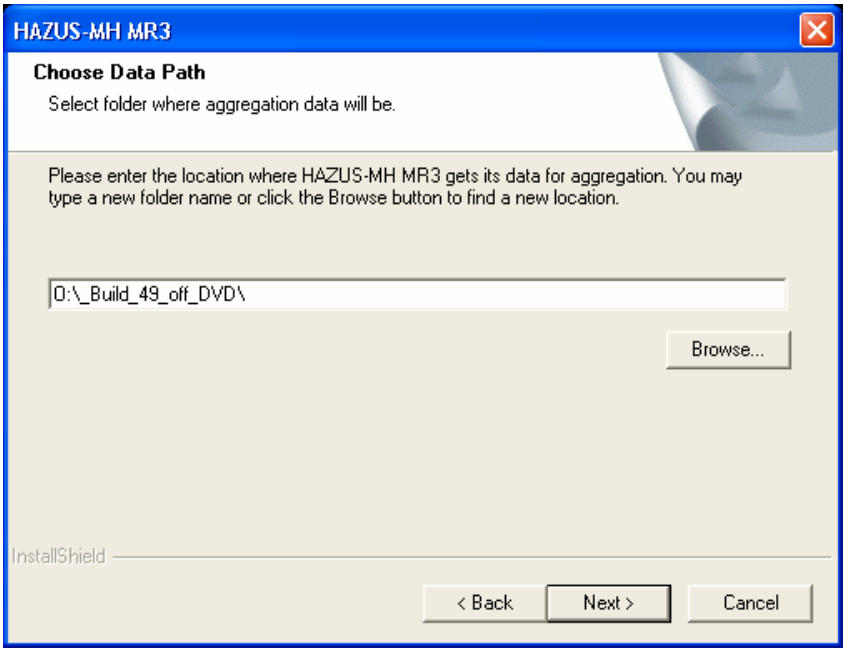

HAZUS-MH MR3
Choose Data Path
Select folder where aggregation data will be.
Please enter the location where HAZUS-MH MR3 gets its data for aggregation. You may type a new folder name or click the Browse button to find a new location.
O:_Build_49_off_DVD\
Browse...
InstallShield
< Back
Next >
Cancel

Figure 2.11 Set Data Path

12. If a custom installation was chosen, the next screen will offer a choice of program modules. One or more hazard modules must be selected (see **Figure 2.12**).

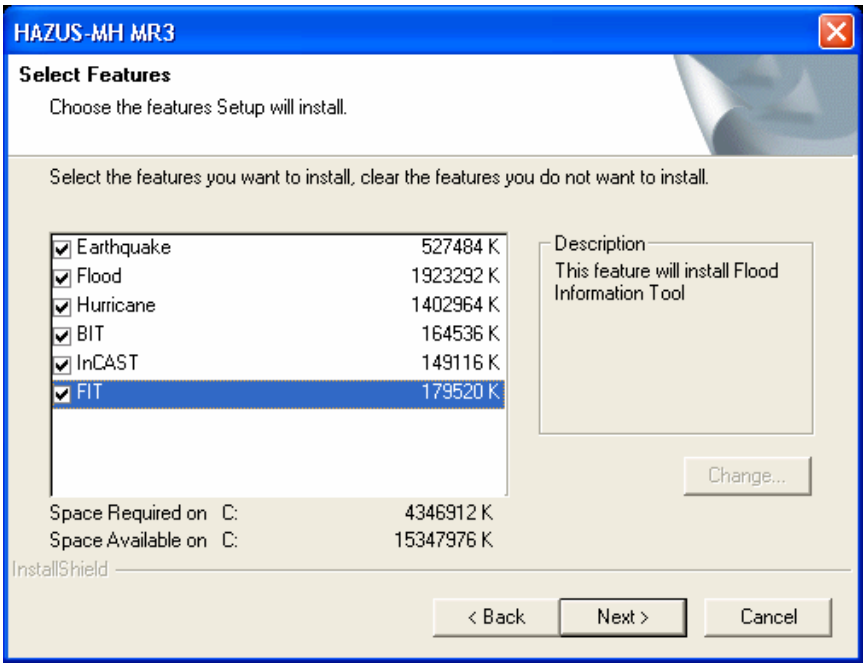


Figure 2.12 Select Each Hazard Module and Tool Program to Install

Here is a brief description of the different components:

- **Earthquake** One of three natural hazard program components.
- **Flood** One of three natural hazard program components.
- **Hurricane** One of three natural hazard program components.
- **BIT** Converts custom data to **HAZUS** format (see Chapter 8)
- **InCAST** is a stand-alone tool to use for collecting inventory data in a format compatible with the **HAZUS** format.

13. Your next screen will show the installation option you selected and the directory paths you designate for the program, region data files, and data path. Figure 2.13 and Figure 2.14 show the screens that will display, depending on whether a complete or custom installation was chosen.

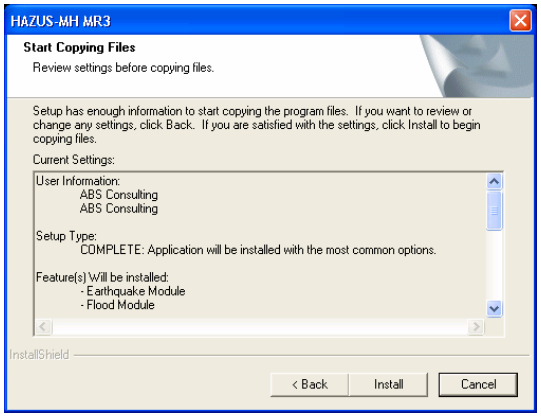

HAZUS-MH MR3
Start Copying Files
Review settings before copying files.
Setup has enough information to start copying the program files. If you want to review or change any settings, click Back. If you are satisfied with the settings, click Install to begin copying files.
Current Settings:
User Information:
ABS Consulting
ABS Consulting
Setup Type:
COMPLETE: Application will be installed with the most common options.
Feature(s) Will be installed:
- Earthquake Module
- Flood Module
InstallShield
< Back
Install
Cancel

Figure 2.13 Complete Installation Settings

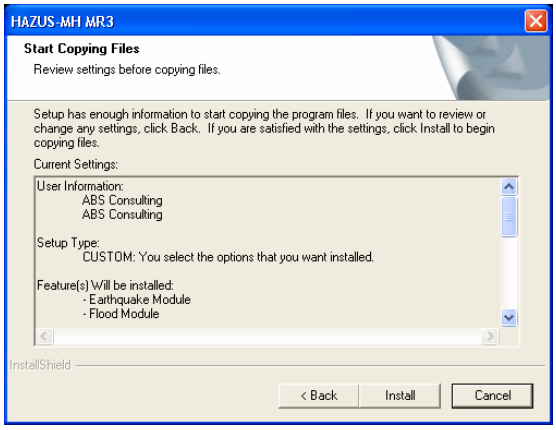

HAZUS-MH MR3
Start Copying Files
Review settings before copying files.
Setup has enough information to start copying the program files. If you want to review or change any settings, click Back. If you are satisfied with the settings, click Install to begin copying files.
Current Settings:
User Information:
ABS Consulting
ABS Consulting
Setup Type:
CUSTOM: You select the options that you want installed.
Feature(s) Will be installed:
- Earthquake Module
- Flood Module
InstallShield
< Back
Install
Cancel

Figure 2.14 Custom Installation Settings

Review the installation settings. Click on the **Back** button to go back to any of the previous windows and change the previous selections. If you are satisfied with your selection, click the **Install** button.

14. It will take five to ten minutes for the program to install. When the installation is complete the dialog box shown in Figure 2.15 will appear and HAZUS program icon will automatically be created on your desktop. Click **Finish** to return to the Windows Setup. It is recommended that your restart your machine.

Figure 2.15 Dialog Box Indicating Successful HAZUS Installation

2.3 Upgrading from HAZUS99 to HAZUS-MH

HAZUS is distinctly different than previous versions of the software. The program conforms to current GIS technology and the object-oriented data structure, or geodatabase. **HAZUS** functions inside of the ArcGIS environment and enhances its spatial analysis capabilities. Data used to calculate risk or loss, and data inventories must be in geodatabase format.

Geodatabases offer many advantages over previous GIS data structures, including a uniform repository for all feature types (*i.e.*, points, lines, and polygons), and more intelligent spatial relationships. **HAZUS** applies the newest GIS technology to improve loss estimation analysis and results.

Inventory data and study regions cannot be used directly in **HAZUS**. Individual inventories can be imported to a geodatabase; regions (i.e. HAZUS99 analysis regions) cannot. Re-run the loss estimation analysis in **HAZUS** to take advantage of the improved inventories, parameter values and model algorithms. See Chapter 5 for details on collecting inventory data.

2.4 Starting the Program

The installation program described in Section 2.2 creates a **HAZUS-MH** icon/shortcut on the computer's desktop. To start the program, double click on the **HAZUS-MH** icon shown in Figure 2.16.

Figure 2.16 HAZUS Icon

In order to enter inventory or run an analysis, you must first create a study region. Creating a study region is discussed in Section 3.1.

2.5 Uninstalling the Program

To uninstall **HAZUS**, go to **Start |Settings| Control Panel** as shown in Figure 2.17.

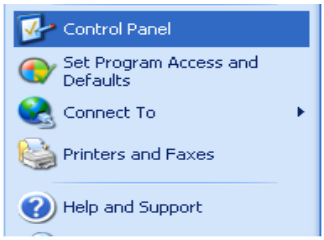


Figure 2.17 Open the Control Panel

From the Control Panel window, double click on **Add/Remove Programs** as shown in Figure 2.18.

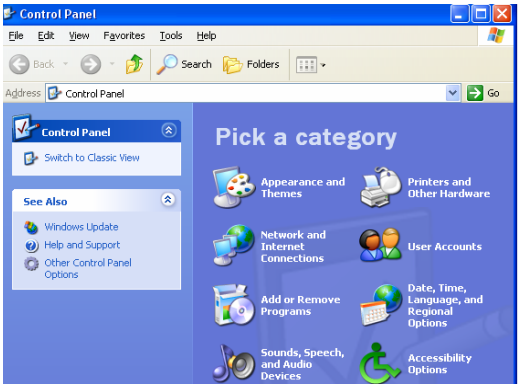


Figure 2.18 Select Add/Remove Programs

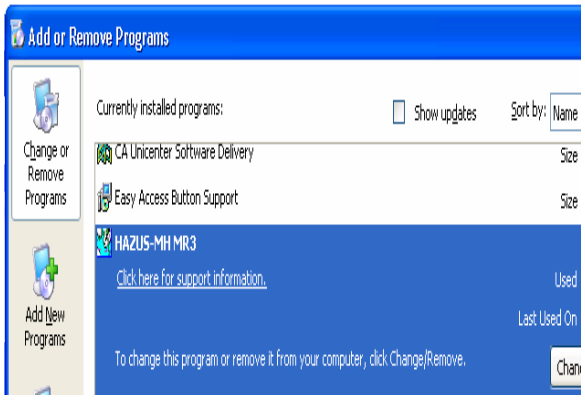


Figure 2.19 Uninstall HAZUS-MH MR3

You will be prompted with an **Add/Remove Program Properties** window as shown in Figure 2.19. Highlight **HAZUS-MH** and double click on the **Change/Remove** button**.** The install wizard will start and provide you with three uninstall options shown in Figure 2.20: Modify your previous installation (ex. Add tools), Repair (reinstall) program components, or Remove all of the previously installed **HAZUS** files.

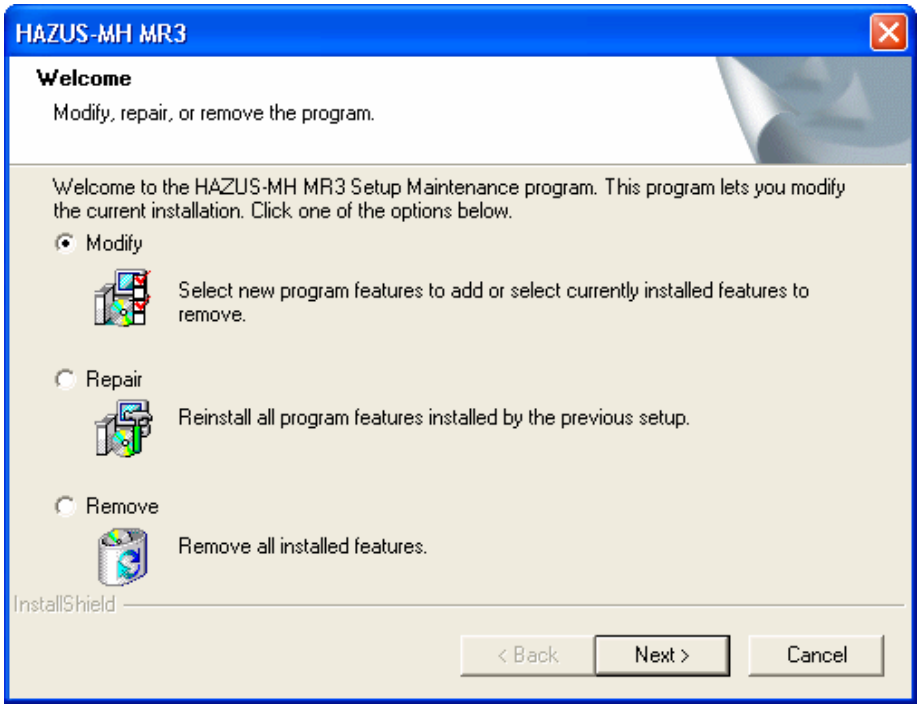

HAZUS-MH MR3
Welcome
Modify, repair, or remove the program.
Welcome to the HAZUS-MH MR3 Setup Maintenance program. This program lets you modify the current installation. Click one of the options below.
Modify
Select new program features to add or select currently installed features to remove.
Repair
Reinstall all program features installed by the previous setup.
Remove
Remove all installed features.
InstallShield
< Back
Next >
Cancel

Figure 2.20 Modify, Repair, or Remove the HAZUS Program

2.6 Program Basics

HAZUS is an ArcGIS-based program with a standard Windows interface that provides a familiar working environment. Unlike the previous versions, **HAZUS-MH** resides on top of ArcMap. The only ArcMap function that has been disabled is table loading. Buttons are added to the ArcMap menu bar to perform **HAZUS** hazard risk analysis and loss modeling functions (see Figure 2.21).

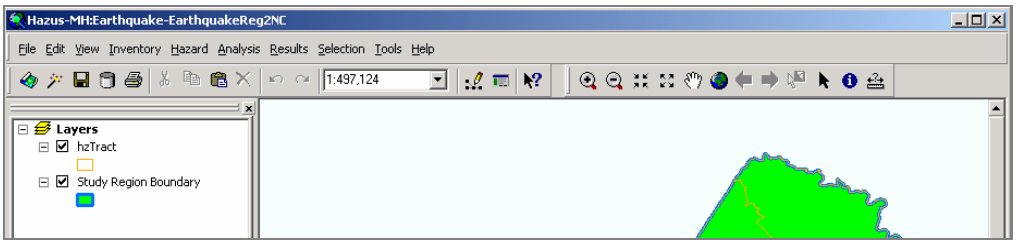


Figure 2.21 HAZUS Menu Bar Adds Functions to ArcMap

The user interface is comprised of a menu bar, tool bar and various screens and windows. These elements follow standard Windows conventions and allow you to manipulate and analyze data within **HAZUS**. This section briefly describes some of the features.

2.6.1 Menu Bar

Functional menus appear alongside the general ArcMap menus: Inventory (Figure 2.22), Hazard (Figure 2.23), Analysis (Figure 2.24), and Results (Figure 2.25). The menu bar is displayed at the top of the screen. **Bold** menu items indicate that the items are available; grayed out menu items are not available. The menus marked with a (*) as described in Table 2.2 below are the menus added by HAZUS-MH to the ArcMap menu.

Table 2.2 HAZUS-MH Menu Items

File	Execute standard software actions such as open table, save and print.
Edit	Edit text and features including cut, copy, and paste.
View	View data and map display. Zoom in or out. Show the geodatabase Table of Contents.
Inventory *	Add, modify, delete and copy inventory information.
Hazard*	Select hazard maps and the scenario event you wish to work with.
Analysis*	Modify the analysis data, parameters and assumptions.
Results*	Used to view and map analysis results.
Insert	Customize the layout view.
Selection	Locate multiple inventory items based on criteria you provide, and search for specific record information.
Tools	Basic GIS utilities menu.
Help	Help files are available for ArcGIS only. Help files for **HAZUS-MH** are not available in the current version, due to budget constraints.

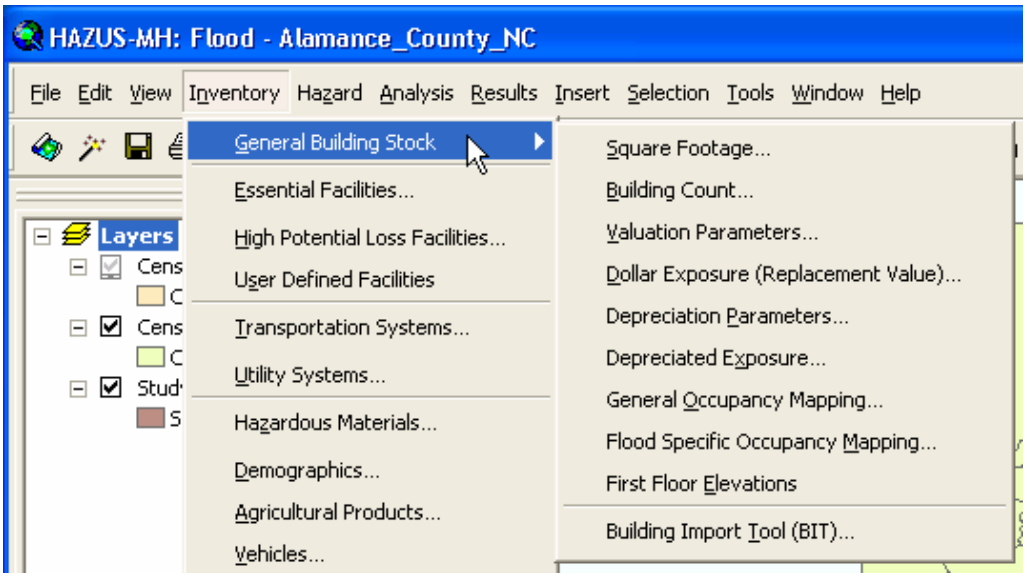


Figure 2.22 HAZUS Inventory Menu

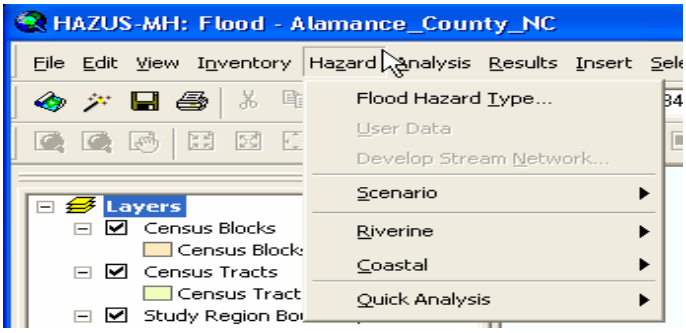


Figure 2.23 HAZUS Hazard Menu

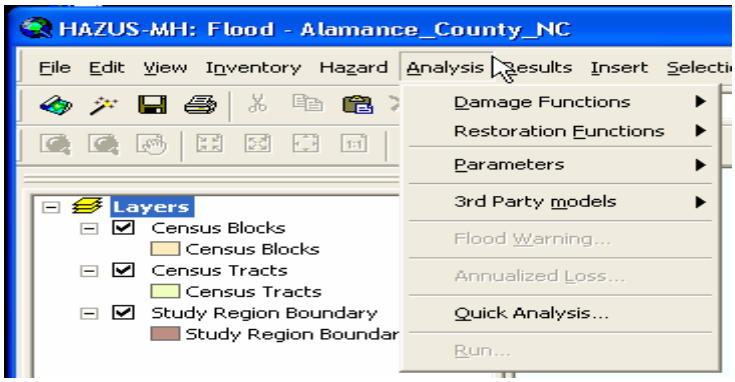


Figure 2.24 HAZUS Analysis Menu

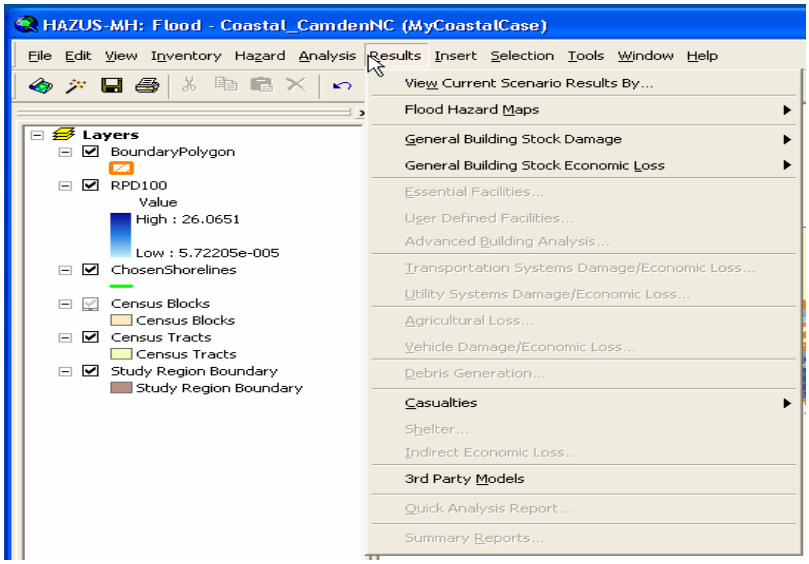


Figure 2.25 HAZUS Results Menu

2.6.2 Tool Bar

A Tool bar is a set of buttons that execute commands by clicking on them. The standard **HAZUS** tool bar appears under the menu bar. The tool bar buttons are used for object selection, zooming in or out, moving around maps, obtaining information, measuring distance and creating points. Details of the ArcMap toolbars can be found in the ArcGIS Help Manual. **Bold** buttons indicate that the buttons are available; grayed out buttons are not available. **HAZUS** adds two tools to the ArcGIS toolbar shown in Figure 2.26. The first tool button accesses the startup dialogue for selection, importing, or creation of an analysis study region. The wand tool allows switching among the hazard types (earthquake, flood, hurricane) the user has loaded.

Figure 2.26 HAZUS Additions to the Toolbar

2.7 Limitations for Use for HAZUS-MH MR3

For Flood Model specific limitations please see Appendix A.5.

Region Size and Analysis Time (based on earthquake model):

S.No	Region Size	Aggregation Time	Analysis Time (Select All Without Contours)	Analysis Time (Rapid Assessment)
1	**150 Tracts**	**6 Minutes**	**10 Minutes**	**7 Minutes**
2	**500 Tracts**	**7 Minutes**	**30 Minutes**	**20 Minutes**
3	**2000 Tracts**	**30 Minutes**	**2 Hours**	**1 Hour 30 Minutes**

Rapid assessment excludes the following modules: Damage by Building Count, All HPLF, AEBM, User Define Structures, All Transportation except Highways roads and bridges and Airports, All Utilities except Potable water and electric power system performance, Inundation, Contours

Virtual Memory:

S.No	Region Size	Min Virtual Memory (Scenario other than AAL)	Min Virtual Memory (Scenario AAL – Eq Only)
1	**150 Tracts**	**328 MB**	**512 MB**
2	**500 Tracts**	**512 MB**	**848 MB**
3	**2000 Tracts**	**1024 MB**	**2048 MB**

The user can expect the following limitations in using HAZUS-MH MR3.

1. SQL Server 2005 Express Edition has a size limit of 4 GB per database, which affects the size of the region you can analyze. The data for the 3 hazards share the 4 GB limit. To work-around the 4 GB database limit, the full version of Microsoft SQL Server must be used. Refer to Appendix H of the User Manual for details.

2. Many functions take a long time to run. Study region aggregation can be speeded up by copying the database to the local hard-disk. The process is as follows:

   The HAZUS installation allows the user to specify the folder where the state data will be copied through the "**Choose Data Path**" dialog in the installation wizard. **If the user has already specified the folder from the "Choose Data Path" dialog during installation where the State Data will be copied from the DATA DVD then the user only needs to perform the step (a) below after installation** and copy the DVD data to the folder specified at the time of installation. If the user did not specify the folder where the state data will be copied during installation or if the user wants to change the folder he/she specified during installation then follow all the steps below.

   NOTE: The "Choose Data Path" dialog in the installation process only specifies the folder where the state data will be copied by the user from the DVD after installation has completed. This dialog doesn't copy the data from the DVD to the specified folder; that has to be done manually by the user after installation.

   a. Copy one or more of the state data folders (e.g., NC1), both the DVD identification files (e.g., D1.txt ^ 1.txt) and "syBoundary.mdb" from the Data DVD to a folder on your hard drive (e.g., D:\HAZUS-Data\).

   b. Next, the user needs to point the program to the new data folder. To do this, click on the Start button, select "Run", type "regedit" and then click OK. Next, navigate through the folder down to the following location:

HKEY_LOCAL MACHINE | SOFTWARE | FEMA | HAZUS-MH | General

c. Now look at the right side of the window and find the entry called "DataPath1". Double click on "DataPath1" and enter the full name of the folder on the hard drive that contains the data copied from the DVDs.

d. IMPORTANT: Make sure the path ends with a "\" and do not change any of the other registry settings

3. Components of independently developed data sets might not line up on maps, for example, the placement of bridges and roads, and facilities.

4. Inventory data and subsequently the Level 1 analysis functionality is unavailable for the US held territories.

Freeing memory using SQL Server Manager

SQL Server can often lock memory as a working set. Because memory is locked, HAZUS or other applications might receive out of memory errors or run slower. To work around this problem, restart the SQL Server service as follows:

1. Restart your computer by clicking **Start,** and then click **Shut Down.** In the "**What do you want the computer to do?"** list, click **Restart.** NOTE: Restarting will close all open applications, so be sure to save your work before choosing to re-start.

2. Restart SQL Server using the SQL Service Manager. Use the following process to open SQL Server Service Manager (SQL SSM) and restart the service:

   a. Close HAZUS and related applications (BIT and InCAST), if they are running.

   b. Open a Command window (Start | Run | Cmd)

   c. Type NET STOP MSSQL$HAZUSPLUSSRVR and hit Enter. You should see a message about the service stopped successfully.

   d. Type NET START MSSQL$HAZUSPLUSSRVR and hit Enter. You should see a message about the service started successfully.

   e. Close the Command window by typing Exit.

Increasing Virtual Memory to Run Large Study Regions

An "out of memory" error might occur when running a flood analysis for a large study region. This occurs if the current page file size is not enough to carry out updates to the SQL Server database. To work around this problem increase the page file size. The process (in Windows 2000. See page xi for instructions in Windows XP.) is as follows:

1. Open the control panel folder and locate the system icon. To open the control panel, click on **Start**, point to **Settings**, and then click **Control Panel**.

2. Double-click the system icon to open the **System Properties** dialog (shown in Figure 2.27).

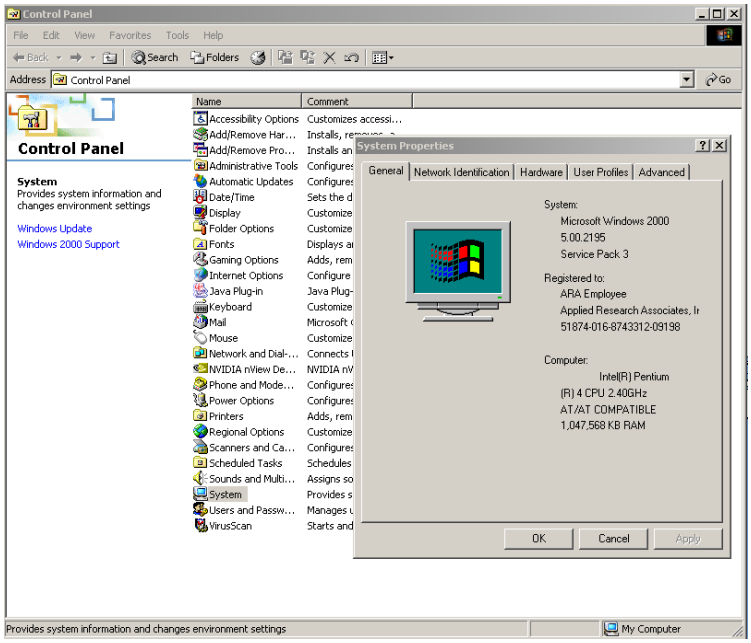


Figure 2.27 Control Panel Folder and the System Properties Dialog

3. On the **Advanced** tab, click **Performance Options**, and under **Virtual memory**, click **Change**. (Figure 2.28 through Figure 2.29)

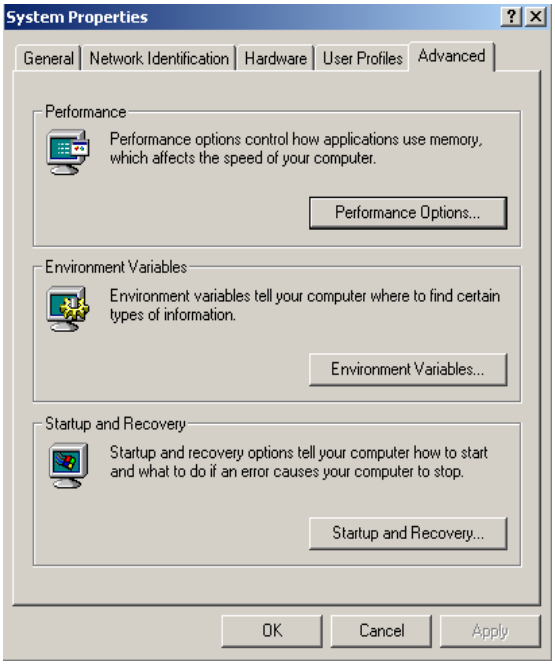

System Properties
General
Network Identification
Hardware
User Profiles
Advanced
Performance
Performance options control how applications use memory, which affects the speed of your computer.
Performance Options...
Environment Variables
Environment variables tell your computer where to find certain types of information.
Environment Variables...
Startup and Recovery
Startup and recovery options tell your computer how to start and what to do if an error causes your computer to stop.
Startup and Recovery...
OK
Cancel
Apply

Figure 2.28 Advanced Page on the System Properties Dialog

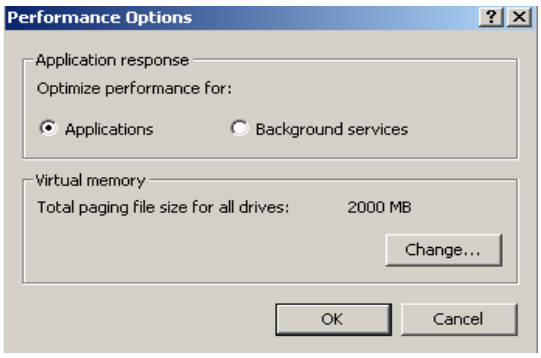


Figure 2.29 Performance Options Dialog

4. In the **Drive** list, click the drive that contains the paging file you want to change. (Figure 2.303)

5. Under **Paging file size for selected drive**, type a new paging file size in megabytes in the **Initial size (MB)** or **Maximum size (MB)** box, and then click **Set**. (Figure 2.30)

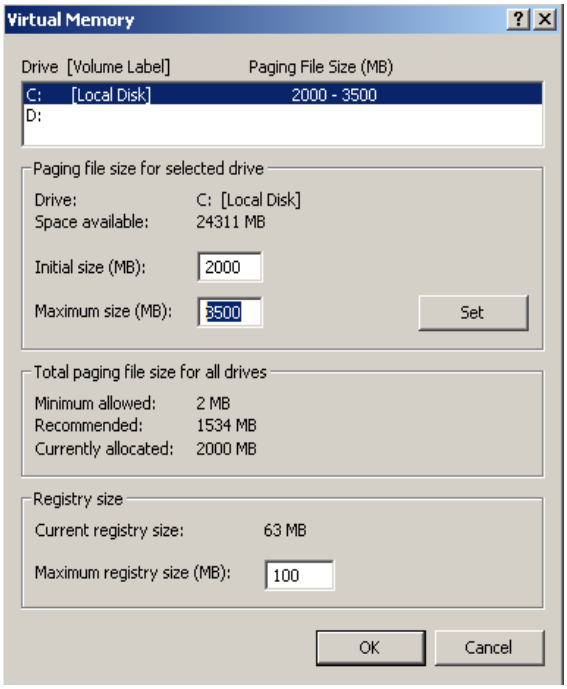


Figure 2.30 Virtual Memory Settings

For best performance, set the initial size to not less than the recommended size under **Total paging file size for all drives**. The recommended size is equivalent to 1.5 times the amount of RAM on your system. If you cannot change the file size or resolve the "out-of memory" error by increasing the page file size, consider creating smaller regions.

Chapter 3 Running HAZUS Flood with Default Data

Running **HAZUS** with default data requires a minimum of effort and technical expertise. **HAZUS** contains a variety of default parameters and databases. The analysis uses data provided with the methodology, such as the general building stock data and broad regional patterns of floodplain code adoption. A small amount of user-supplied input is required to run the analysis, but this input can be gathered by contacting government agencies or referring to readily available published sources.

The results of a **HAZUS** run using default data will have large margins of error. This type of output would be appropriate for regional, state or national level analyses. At the local level, this type of analysis is most appropriate as an initial loss estimation study to determine where more detailed data collection and analysis are warranted. Conducting a run using default data is an excellent way to become familiar with using **HAZUS**.

Some components of the methodology cannot be performed in an analysis using default data because they require more detailed inventory than that provided with the methodology. For example, you can only analyze damage and loss for wastewater systems if you provide a detailed inventory of the facilities.

This Section takes you step-by-step through the process of producing and presenting flood loss estimates from default data with **HAZUS**.

3.1 Defining the Study Region

The first step of any **HAZUS** run is defining the *study region*, the geographic area that will be analyzed. The first time you use **HAZUS**, you must define a study region before you can access the program. In subsequent uses, you may open an existing study region or define a new one.

The study region can be any combination of states, counties, census tracts or census blocks. Currently if you want to create a study region that matches a city boundary, you will need to know what census tracts are contained within the city. In many cases, the region boundary will follow political boundaries such as counties, or those municipalities that are city-counties. It is important to note that **HAZUS** will not include any inventory data outside the area you have defined as the study region. Some hazard specific data required for the analysis may extend beyond the study region you have selected. In fact, **HAZUS** will not allow you to add any facilities that are not contained within the study region boundary.

The methodology is based upon using census blocks as the smallest geographic unit (this is different from the earthquake model which uses census tract as the smallest unit). A census block is the smallest Census Bureau geographic entity; it generally is an area bounded by streets, streams, and the boundaries of legal and statistical entities, such as metropolitan area, census tracts, etc. every effort is made to make the census block as homogeneous as possible in terms of income, population and other characteristics.

Immediately upon opening the **HAZUS** program, you are prompted to create or open a study region, as shown in Figure 3.1. If you have already created a study region, you can open it now. If there are no study regions created on your machine, you will need to create one now. Select the button labeled *Create a new region* and click *OK*. This Section will create and use a study region for Alamance County, North Carolina as an example.

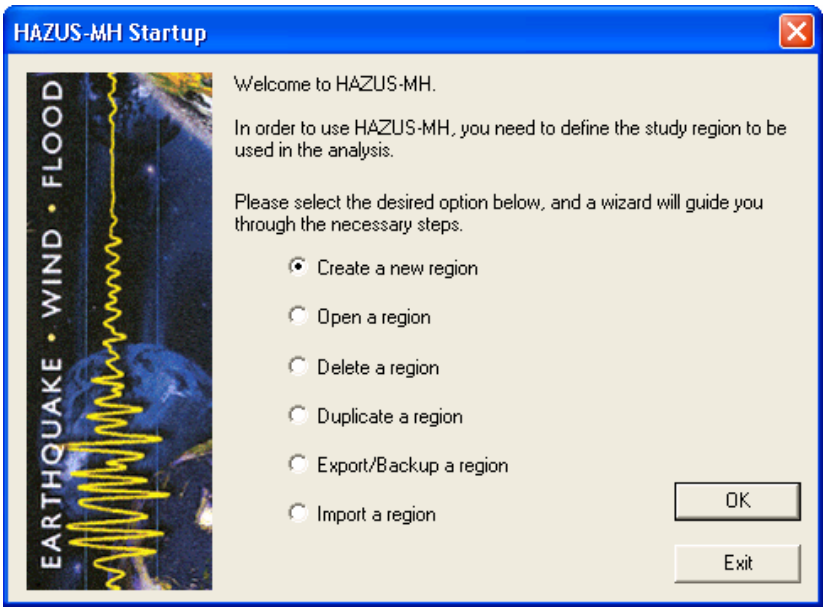

HAZUS-MH Startup
EARTHQUAKE • WIND • FLOOD
Welcome to HAZUS-MH.
In order to use HAZUS-MH, you need to define the study region to be used in the analysis.
Please select the desired option below, and a wizard will guide you through the necessary steps.
Create a new region
Open a region
Delete a region
Duplicate a region
Export/Backup a region
Import a region
OK
Exit

Figure 3.1 HAZUS Start-up Window

Next, **HAZUS** will lead you through the process of creating a study region. First you will be prompted to name your study region. You may also choose to write a description of the study region that you will be able to view when opening study regions later. This is shown in Figure 3.2. Be sure not to include leading or trailing spaces in the study region name. Press **Next** when you are ready to proceed.

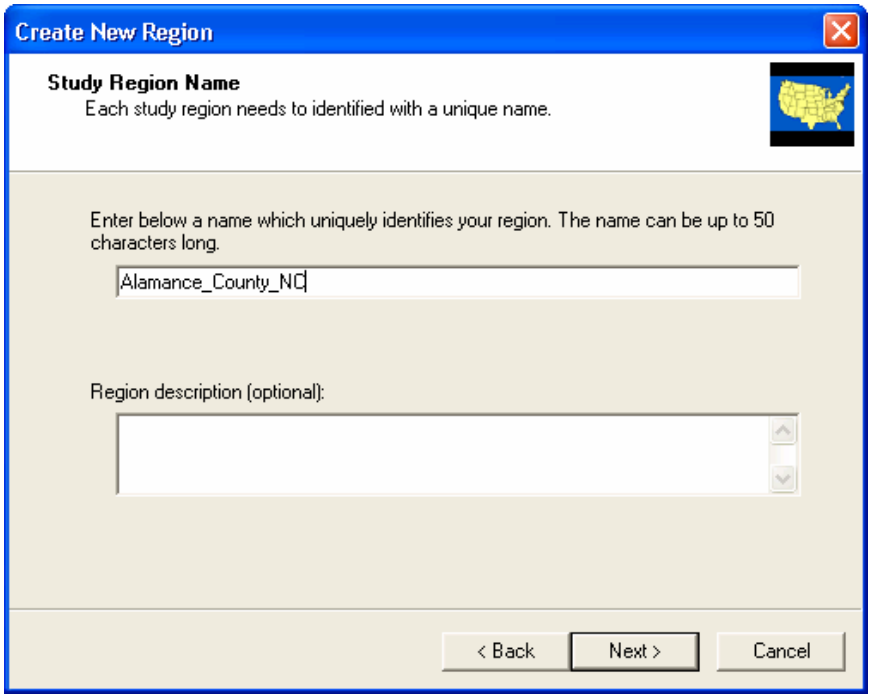

Create New Region
Study Region Name
Each study region needs to identified with a unique name.
Enter below a name which uniquely identifies your region. The name can be up to 50 characters long.
Alamance_County_NC
Region description (optional):
< Back
Next >
Cancel

Figure 3.2 Naming the Study Region

The next window will prompt you to select which hazards you are interested in examining for your community. The analysis for each hazard requires different default information, and the study region you create will include only the information needed for the hazards you intend to run. For this example, we select only *Flood*, as shown in Figure 3.3. Note it is recommended that the flood user limit the size of their study regions to approximately four counties in size due to the large amount of data required for the flood analysis.

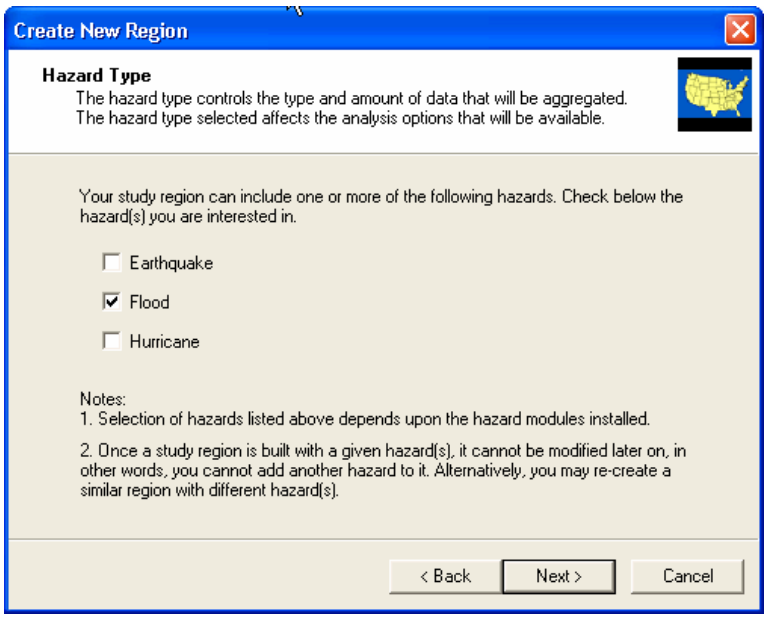

Create New Region
Hazard Type
The hazard type controls the type and amount of data that will be aggregated.
The hazard type selected affects the analysis options that will be available.
Your study region can include one or more of the following hazards. Check below the hazard(s) you are interested in.
Earthquake
Flood
Hurricane
Notes:
1. Selection of hazards listed above depends upon the hazard modules installed.
2. Once a study region is built with a given hazard(s), it cannot be modified later on, in other words, you cannot add another hazard to it. Alternatively, you may re-create a similar region with different hazard(s).
< Back
Next >
Cancel

Figure 3.3 Select Hazards for a Study Region

The next step in creating a study region is shown below in Figure 3.4 is to select the level of detail you would like for your study region.

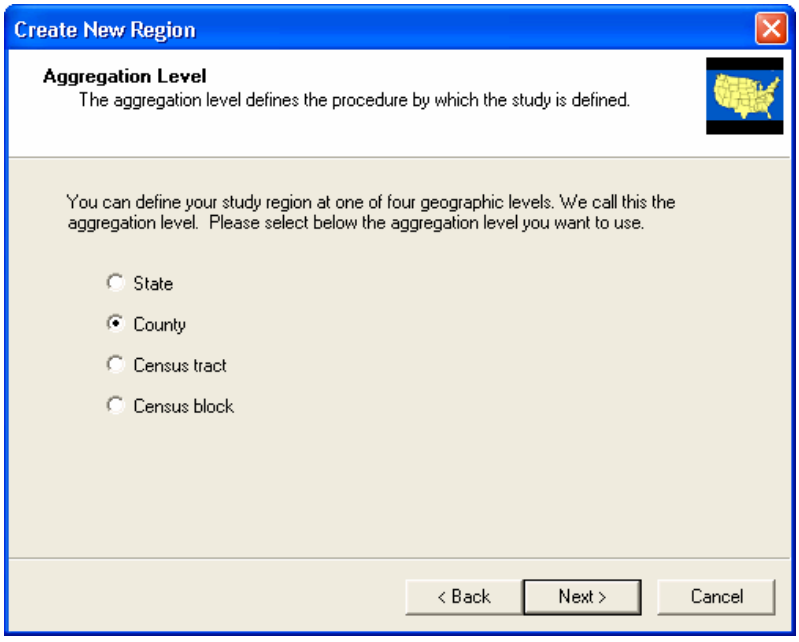

Create New Region
Aggregation Level
The aggregation level defines the procedure by which the study is defined.
You can define your study region at one of four geographic levels. We call this the aggregation level. Please select below the aggregation level you want to use.
State
County
Census tract
Census block
< Back
Next >
Cancel

Figure 3.4 Study Region Aggregation Level

The aggregation level defines the resolution at which your study region will be defined. If you wish to be able to perform analyses anywhere within a county, select the "County" aggregation

level. If you wish to select a sub-county study region by census tracts or blocks, select the appropriate radio button. The aggregation level does not affect the resolution of results. All flood model results are computed at the census block level, regardless of the level of aggregation.

The next steps involve selecting the state your study region is located in, and then the county or counties to be included in the region. You can do this by selecting from a list of states and then a list of counties, or by selecting both from a map. For example, you can select a county individually by single clicking on its name (or select multiple counties by single-clicking on the name of the first county and holding down the "Ctrl" key while single-clicking on the remaining counties). These steps are illustrated in Figure 3.5 and Figure 3.6.

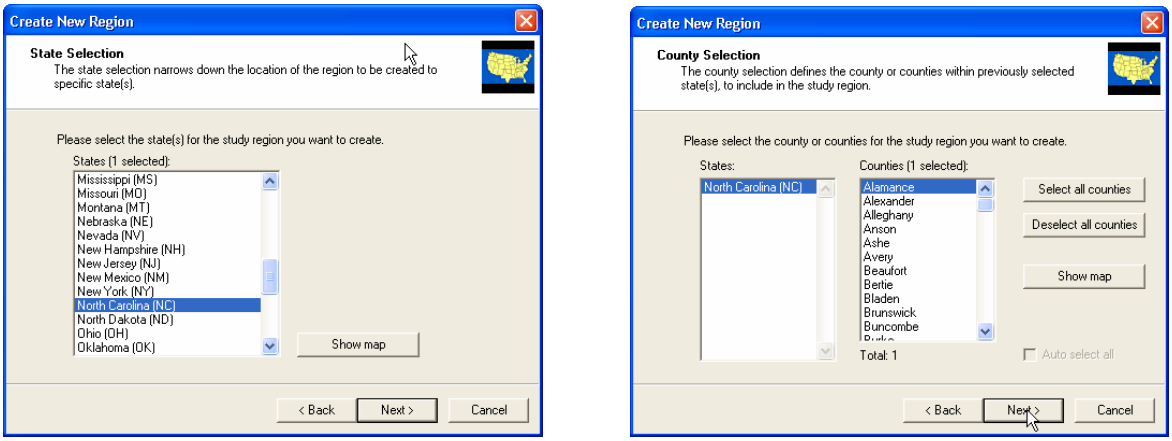


Figure 3.5 Select State and Counties by List

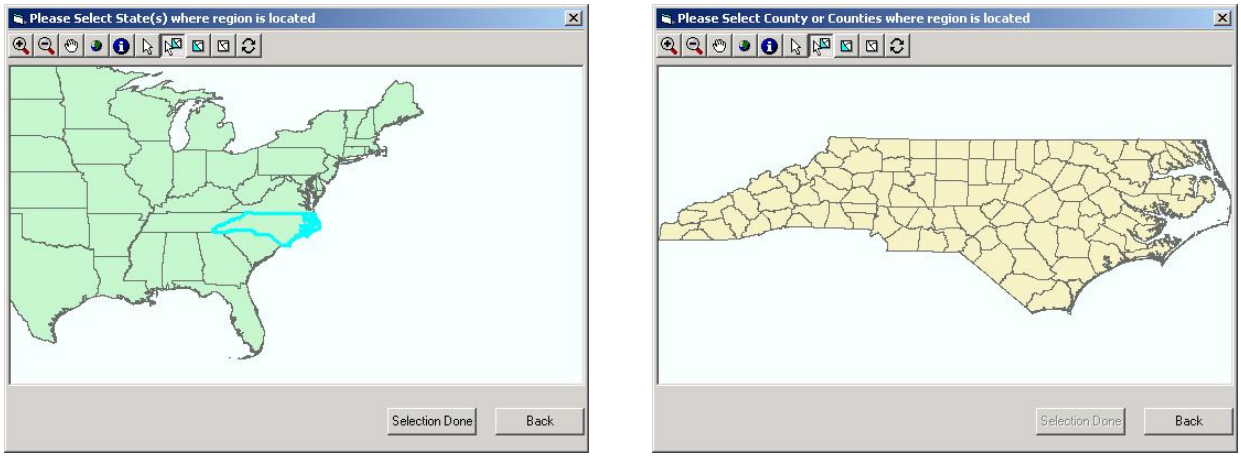


Figure 3.6 Select State and County by Map

If you choose to select your state and counties by map, you can use the "Identify" tool (the button with the lower-case *i*) to click on an area to identify it.

After identifying the state and counties and clicking *Next*, **HAZUS** will start to build the study region. The process of building a study region will take some time, depending on the processor speed of your computer and the size and level of detail of the study region you have defined. For a study region of one county, it could take **HAZUS** between five minutes and two hours to process the information. This process requires significant time because of the large amounts of data that are being loaded into the study region.

When the study region is complete, the same window that appeared when you first opened **HAZUS** will appear again. This time, you should select *Open a region*.

HAZUS will present you with a list of all of the study regions that have been created on your computer. If the study region you just created is your first, you will only see one region listed. In Figure 3.7, there are two study regions to choose from, meaning that the Alamance County, North Carolina region created in the example was the second region to be created on that computer. Select the name of the region you just created and click *Next* to open it.

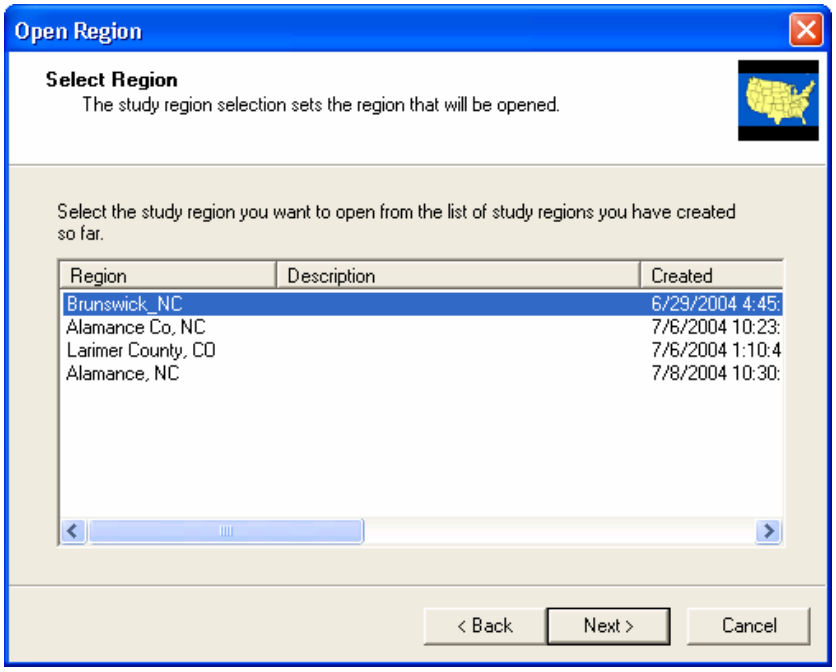


Figure 3.7 Selecting which Study Region to Open

The study region will open in the **HAZUS** window, showing the outline of the region you have created along with a delineation of the census tracts, as shown in Figure 3.8 for Alamance County, North Carolina.

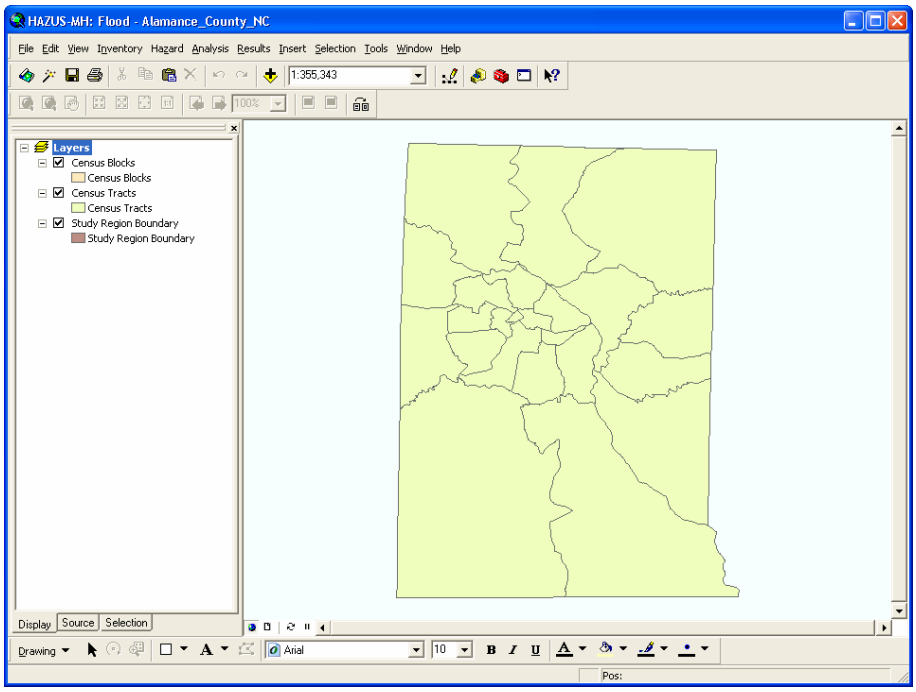


Figure 3.8 The Opened Study Region

3.2 Examining Inventory Data

As noted, this Section describes how to conduct a **HAZUS** analysis using the default data and methods provided with the program. This means that we will not change any of the inventory data that the program has compiled. Later Sections examine how to alter the data and methods. We will, however, examine these data to better understand the information that **HAZUS** includes.

3.2.1 Inventory Menu Items

If you click on the *Inventory* menu, you will see listed all of the types of inventory data that are included in your study region. Figure 3.9 shows these menu items and the submenu items for *General Building Stock.*

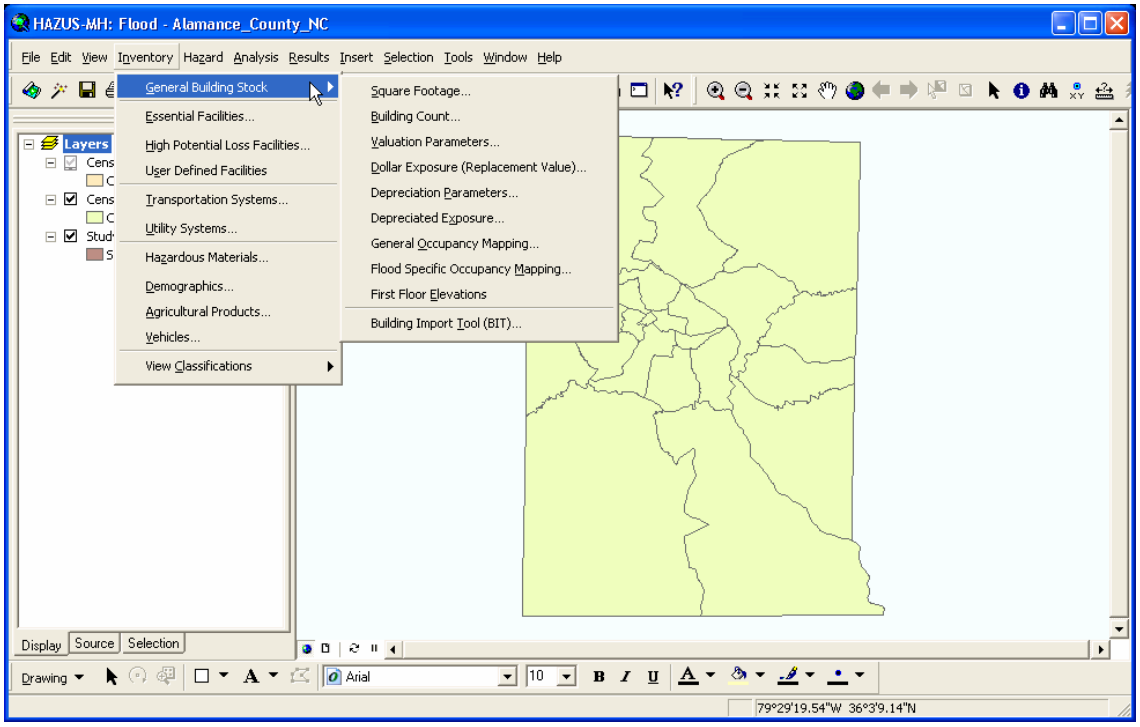


Figure 3.9 Inventory and General Building Stock Menu Items

These menu items include both listings of inventory, such as the number of buildings in the study region, and presentation of some built-in calculation parameters, such as parameters used to determine the value of the general building stock in the study region.

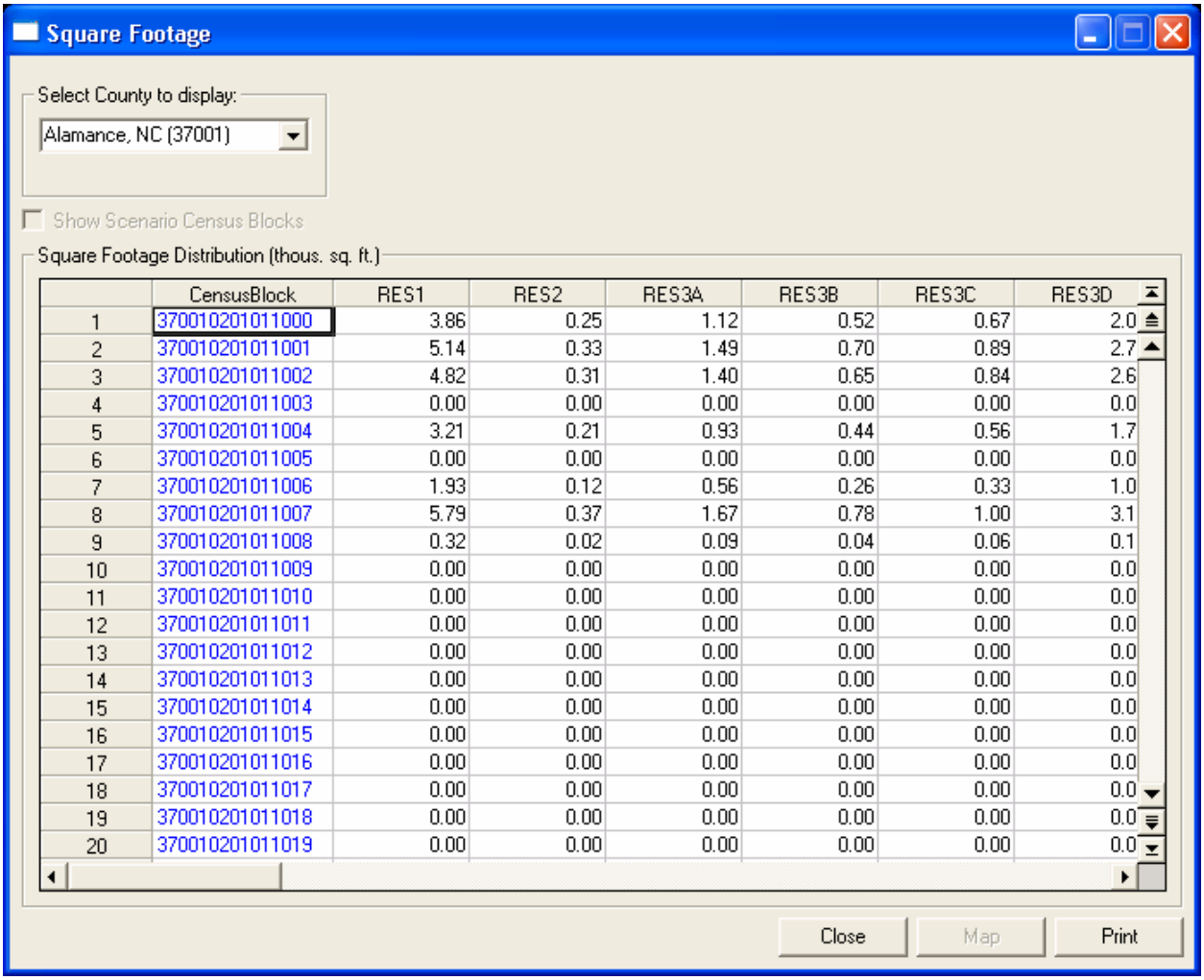
In this section, we will examine several of the inventory and parameter items in both table and map forms. You should familiarize yourself with all of the items by selecting each menu item and exploring all of the windows.

3.2.2 General Building Stock

The General Building Stock (GBS) includes residential, commercial, industrial, agricultural, religious, government, and educational buildings. Damage is estimated in percent and is weighted by the area of inundation at a given depth for a given census block. It is assumed that the entire composition of the GBS within a given census block is evenly distributed throughout the block.

3.2.2.1 Square Footage

The Square Footage browser allows you to view or modify the general building stock square footage by specific occupancy and census tract. The data in this browser are common to all three hazards.



	CensusBlock	RES1	RES2	RES3A	RES3B	RES3C	RES3D
1	370010201011000	3.86	0.25	1.12	0.52	0.67	2.0
2	370010201011001	5.14	0.33	1.49	0.70	0.89	2.7
3	370010201011002	4.82	0.31	1.40	0.65	0.84	2.6
4	370010201011003	0.00	0.00	0.00	0.00	0.00	0.0
5	370010201011004	3.21	0.21	0.93	0.44	0.56	1.7
6	370010201011005	0.00	0.00	0.00	0.00	0.00	0.0
7	370010201011006	1.93	0.12	0.56	0.26	0.33	1.0
8	370010201011007	5.79	0.37	1.67	0.78	1.00	3.1
9	370010201011008	0.32	0.02	0.09	0.04	0.06	0.1
10	370010201011009	0.00	0.00	0.00	0.00	0.00	0.0
11	370010201011010	0.00	0.00	0.00	0.00	0.00	0.0
12	370010201011011	0.00	0.00	0.00	0.00	0.00	0.0
13	370010201011012	0.00	0.00	0.00	0.00	0.00	0.0
14	370010201011013	0.00	0.00	0.00	0.00	0.00	0.0
15	370010201011014	0.00	0.00	0.00	0.00	0.00	0.0
16	370010201011015	0.00	0.00	0.00	0.00	0.00	0.0
17	370010201011016	0.00	0.00	0.00	0.00	0.00	0.0
18	370010201011017	0.00	0.00	0.00	0.00	0.00	0.0
19	370010201011018	0.00	0.00	0.00	0.00	0.00	0.0
20	370010201011019	0.00	0.00	0.00	0.00	0.00	0.0

Figure 3.10 Square Footage Browser

3.2.2.2 Building Count

The Building Count browser allows you to view the general building stock count by census block. Each census block located within the study region appears in the left-hand column of the table, identified by the number assigned by the US Census Bureau. For each census block, the total number of buildings is listed, along with the number of buildings assigned to each category of use or general occupancy. **HAZUS** identifies seven general occupancy categories (residential, commercial, industrial, agriculture, religion/non-profit, government and education), which are explained more fully in the Technical Manual. When viewing the building counts by specific occupancy, you can modify the data. When viewed by general occupancy, general building type, or specific building type, the data are read-only. The data displayed in this browser are common to all three hazards (except when viewed by specific building type).

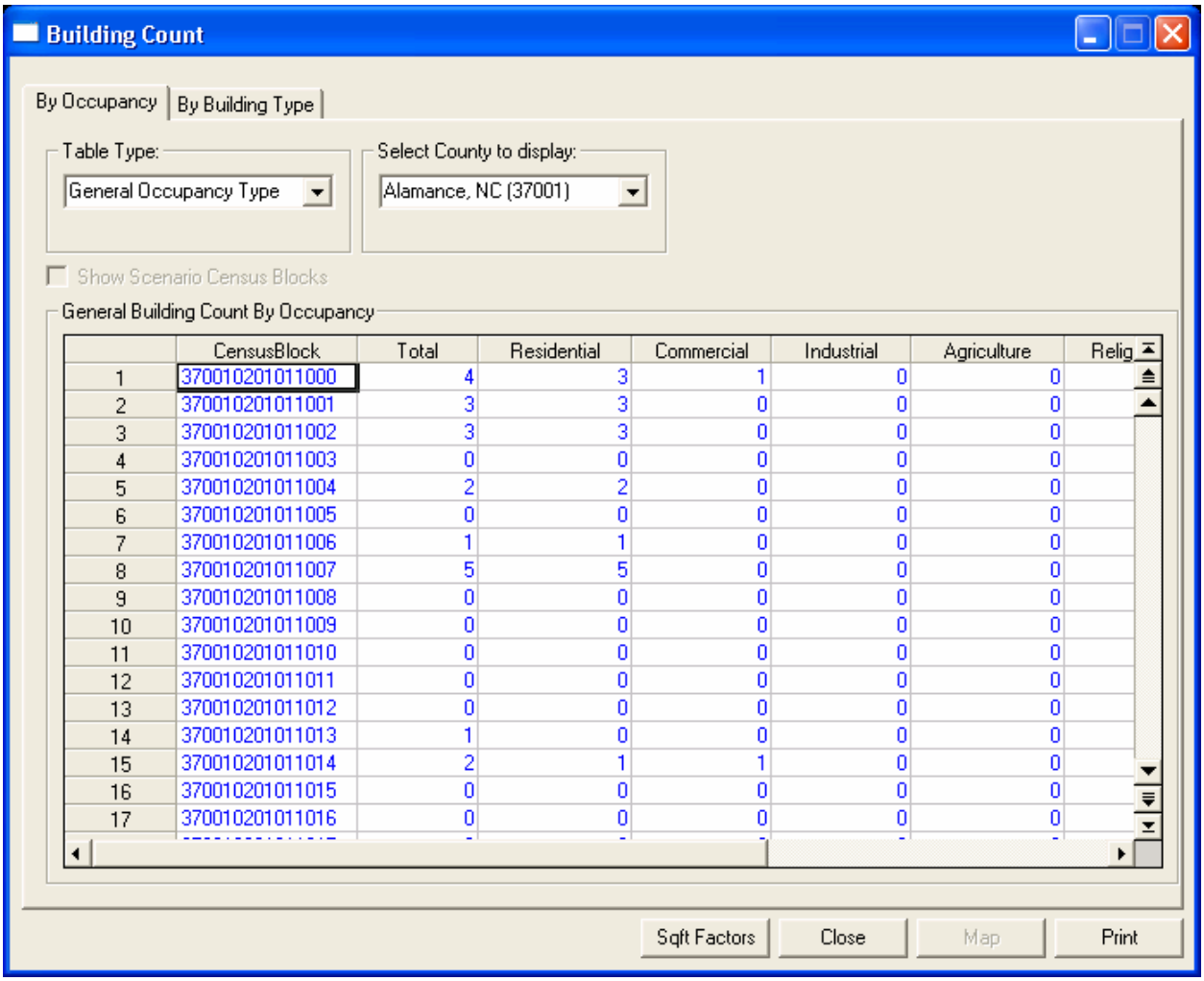
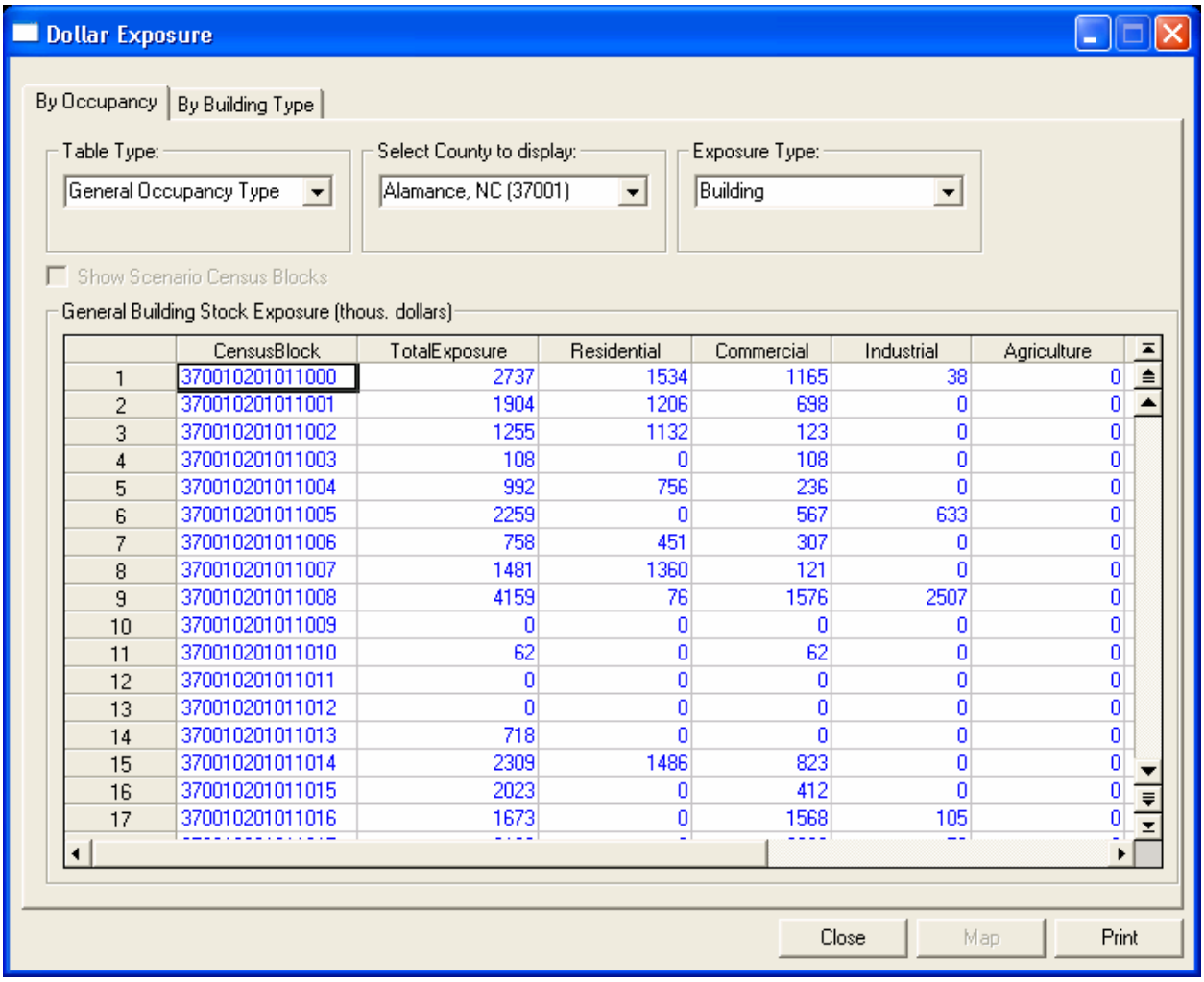


Figure 3.11 Building Count Browser

3.2.2.3 Dollar Exposure

The Dollar Exposure browser allows you to view the general building stock dollar exposure by census tract. When viewing the dollar exposures by specific occupancy, you can modify the data. When viewed by general occupancy, general building type, or specific building type, the data are read-only. The data displayed in this browser are common to all three hazards (except when viewed by specific building type).



	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370010201011000	2737	1534	1165	38	0
2	370010201011001	1904	1206	698	0	0
3	370010201011002	1255	1132	123	0	0
4	370010201011003	108	0	108	0	0
5	370010201011004	992	756	236	0	0
6	370010201011005	2259	0	567	633	0
7	370010201011006	758	451	307	0	0
8	370010201011007	1481	1360	121	0	0
9	370010201011008	4159	76	1576	2507	0
10	370010201011009	0	0	0	0	0
11	370010201011010	62	0	62	0	0
12	370010201011011	0	0	0	0	0
13	370010201011012	0	0	0	0	0
14	370010201011013	718	0	0	0	0
15	370010201011014	2309	1486	823	0	0
16	370010201011015	2023	0	412	0	0
17	370010201011016	1673	0	1568	105	0

Figure 3.12 Dollar Exposure Browser

3.2.2.4 Depreciation Parameters

The Depreciation Parameters browser allows you to view the median year built and median age of a census block. The parameter for the depreciation of buildings is based on the age of the building. These parameters are used to determine the depreciated exposure of a census block as seen below in Figure 3.13.

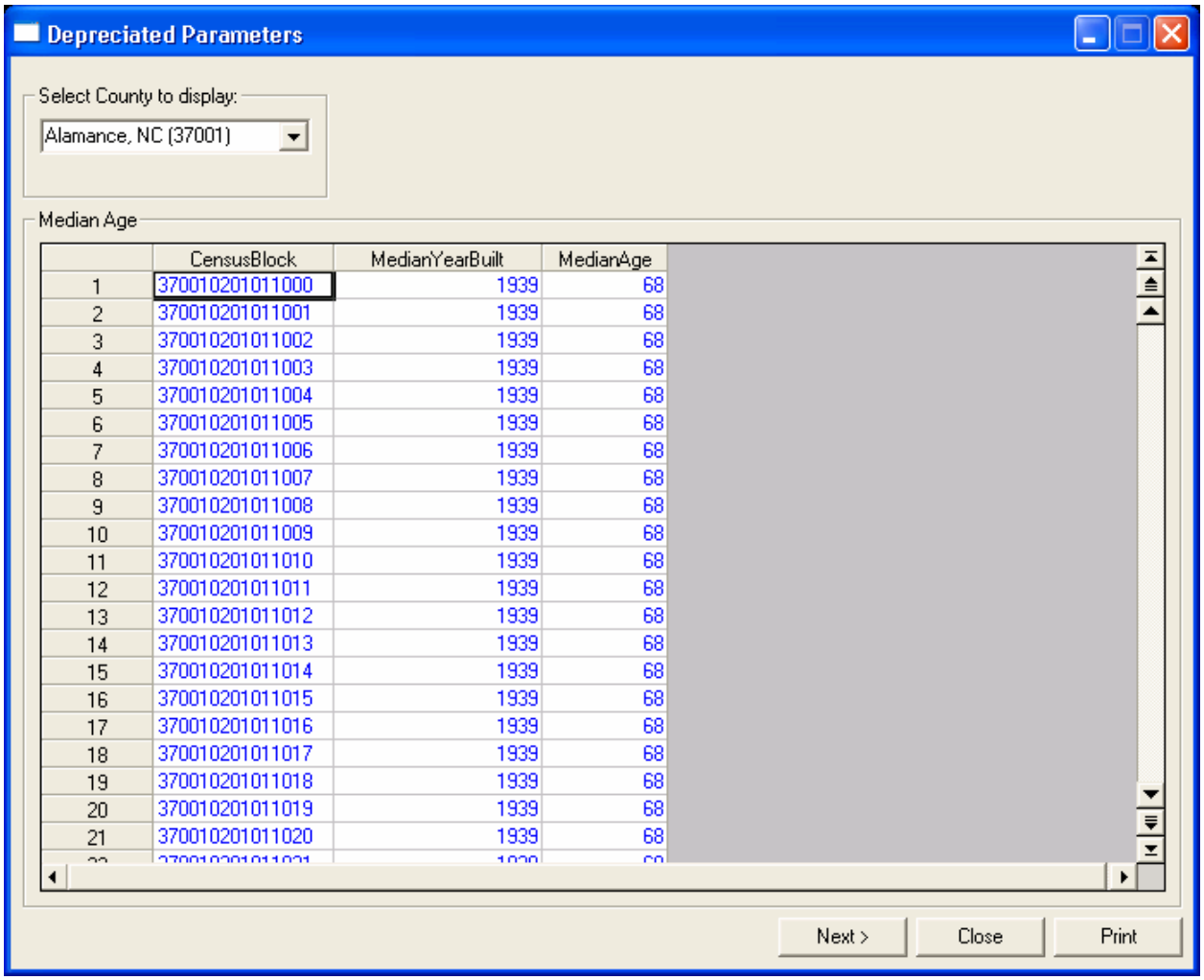
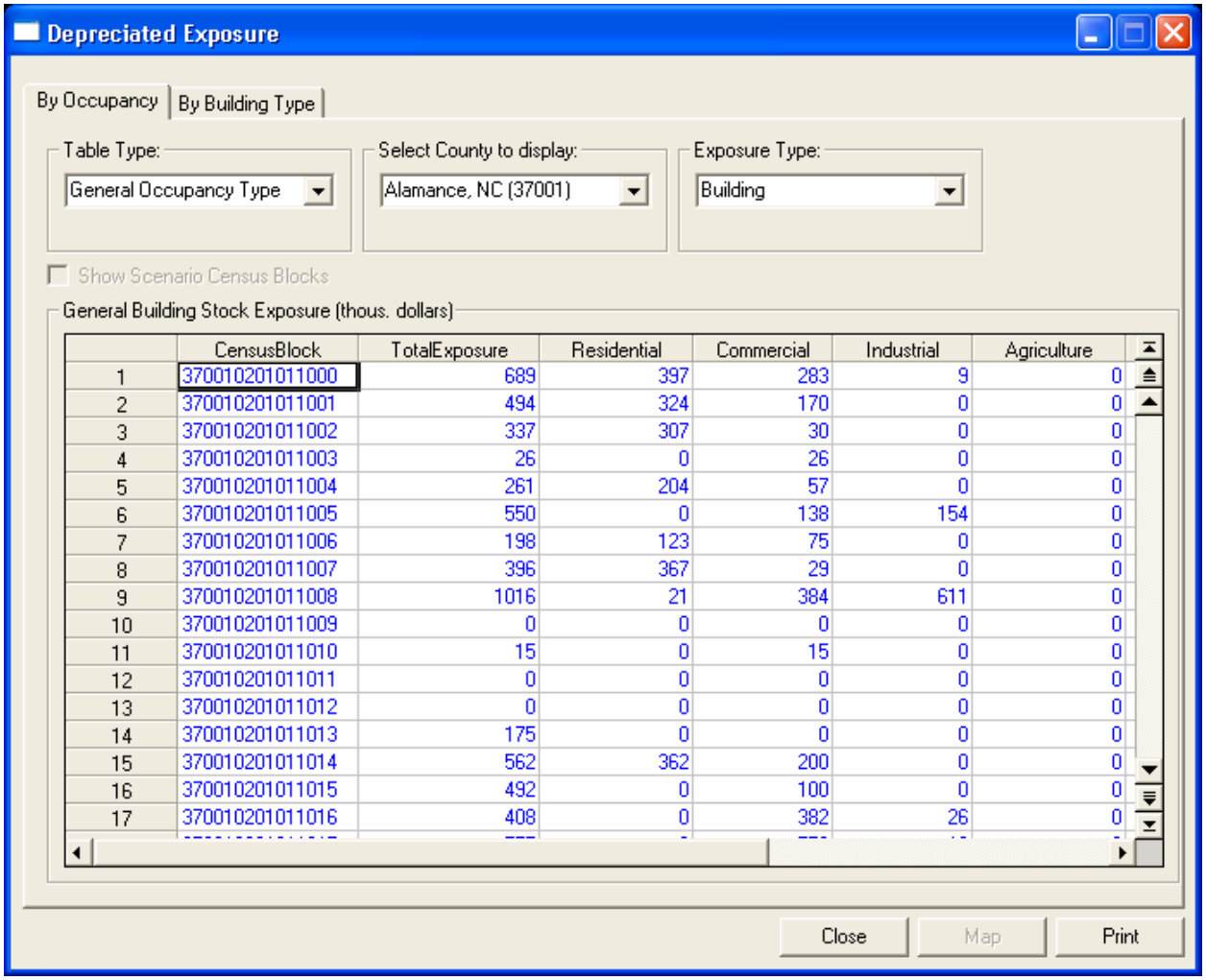


Figure 3.13 Depreciation Parameters Browser

3.2.2.5 Depreciated Exposure

The Depreciated Exposure browser allows you to view the total exposure (in thousands of dollars) by occupancy or by building type. The depreciated exposure is determined by subtracting the median age of a census block (as seen in Figure 3.14) from the current calendar date to get the age of the building. That age is then multiplied to a depreciation curve that will determine the depreciated value to the census block.



	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370010201011000	689	397	283	9	0
2	370010201011001	494	324	170	0	0
3	370010201011002	337	307	30	0	0
4	370010201011003	26	0	26	0	0
5	370010201011004	261	204	57	0	0
6	370010201011005	550	0	138	154	0
7	370010201011006	198	123	75	0	0
8	370010201011007	396	367	29	0	0
9	370010201011008	1016	21	384	611	0
10	370010201011009	0	0	0	0	0
11	370010201011010	15	0	15	0	0
12	370010201011011	0	0	0	0	0
13	370010201011012	0	0	0	0	0
14	370010201011013	175	0	0	0	0
15	370010201011014	562	362	200	0	0
16	370010201011015	492	0	100	0	0
17	370010201011016	408	0	382	26	0

Figure 3.14 Depreciated Exposure Browser

3.2.2.6 General Occupancy Mapping

Shared among the three models, the General Occupancy Mapping dialog allows the user to define the distribution of general building types (e.g., Wood) for their study region. The default distribution is not editable by the user and is assigned to all of the census blocks within the study region. There is one General Occupancy Mapping scheme per state and a study region

consisting of more than one state will display the default schemes for both states. Figure 3.15 below shows the General Occupancy Mapping Scheme as seen when opened by the user.

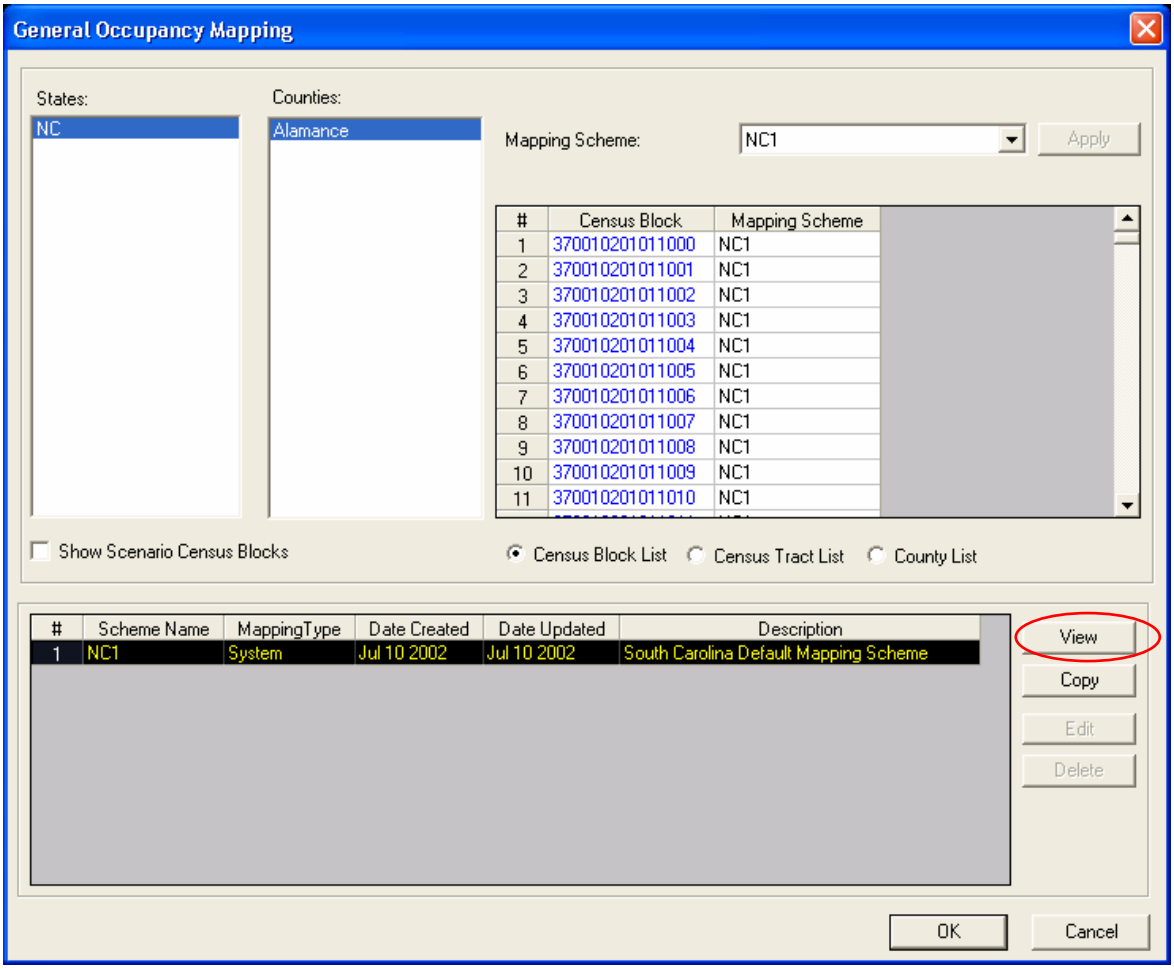
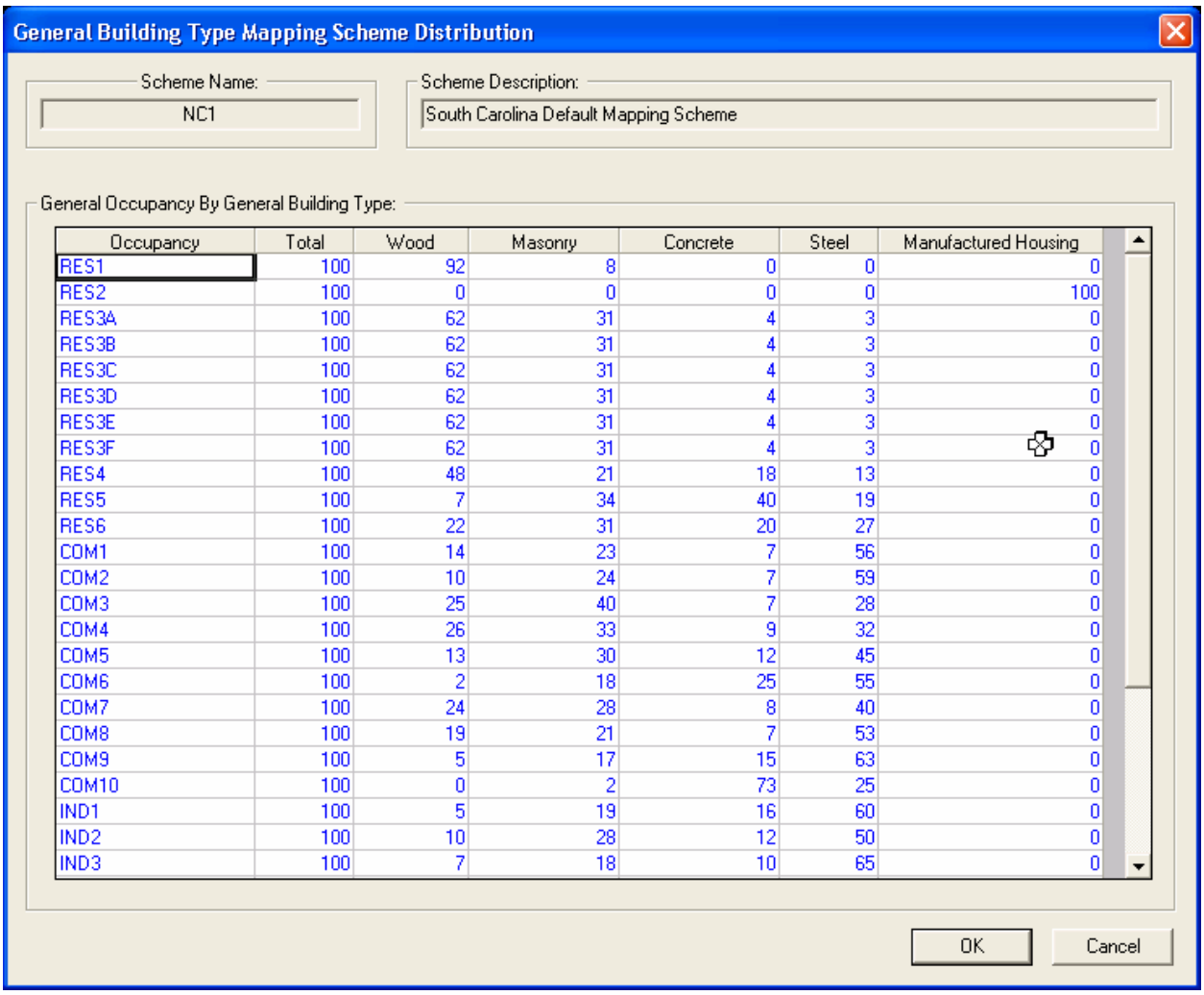


Figure 3.15 General Occupancy Mapping Overview

Highlighting the default scheme in the lower grid allows the user to view the default scheme. By selecting the **View** button (circled) the dialog seen in Figure 3.16 will open for the user to view the default distribution.



Occupancy	Total	Wood	Masonry	Concrete	Steel	Manufactured Housing
RES1	100	92	8	0	0	0
RES2	100	0	0	0	0	100
RES3A	100	62	31	4	3	0
RES3B	100	62	31	4	3	0
RES3C	100	62	31	4	3	0
RES3D	100	62	31	4	3	0
RES3E	100	62	31	4	3	0
RES3F	100	62	31	4	3	0
RES4	100	48	21	18	13	0
RES5	100	7	34	40	19	0
RES6	100	22	31	20	27	0
COM1	100	14	23	7	56	0
COM2	100	10	24	7	59	0
COM3	100	25	40	7	28	0
COM4	100	26	33	9	32	0
COM5	100	13	30	12	45	0
COM6	100	2	18	25	55	0
COM7	100	24	28	8	40	0
COM8	100	19	21	7	53	0
COM9	100	5	17	15	63	0
COM10	100	0	2	73	25	0
IND1	100	5	19	16	60	0
IND2	100	10	28	12	50	0
IND3	100	7	18	10	65	0

Figure 3.16 General Occupancy Mapping Scheme Distribution by Building Type

As seen in the figure, the building type distribution is defined by the specific occupancies used in the three hazard models. The blue text indicates that the user cannot edit the text. If the user selects the **Copy** button immediately below the **View** button, the user will see the dialog shown in Figure 3.17 below where the user can name the new mapping scheme

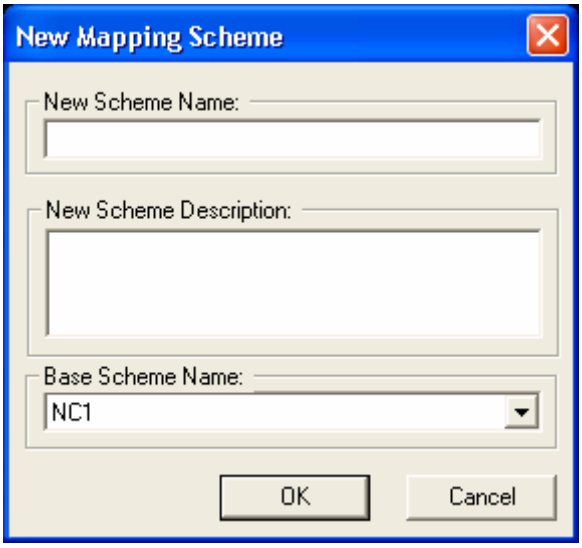


Figure 3.17 New Mapping Scheme Dialog

The user is required to enter a New Scheme Name, which will be displayed in the Mapping Scheme dialog. The user may want to enter a New Scheme Description to distinguish this scheme from others should the user create multiple schemes. The Base Scheme Name is not editable, and provides the user with an indication of the mapping scheme that served as the basis for the new scheme. When the user clicks on **OK**, the dialog seen in Figure 3.18 is opened.

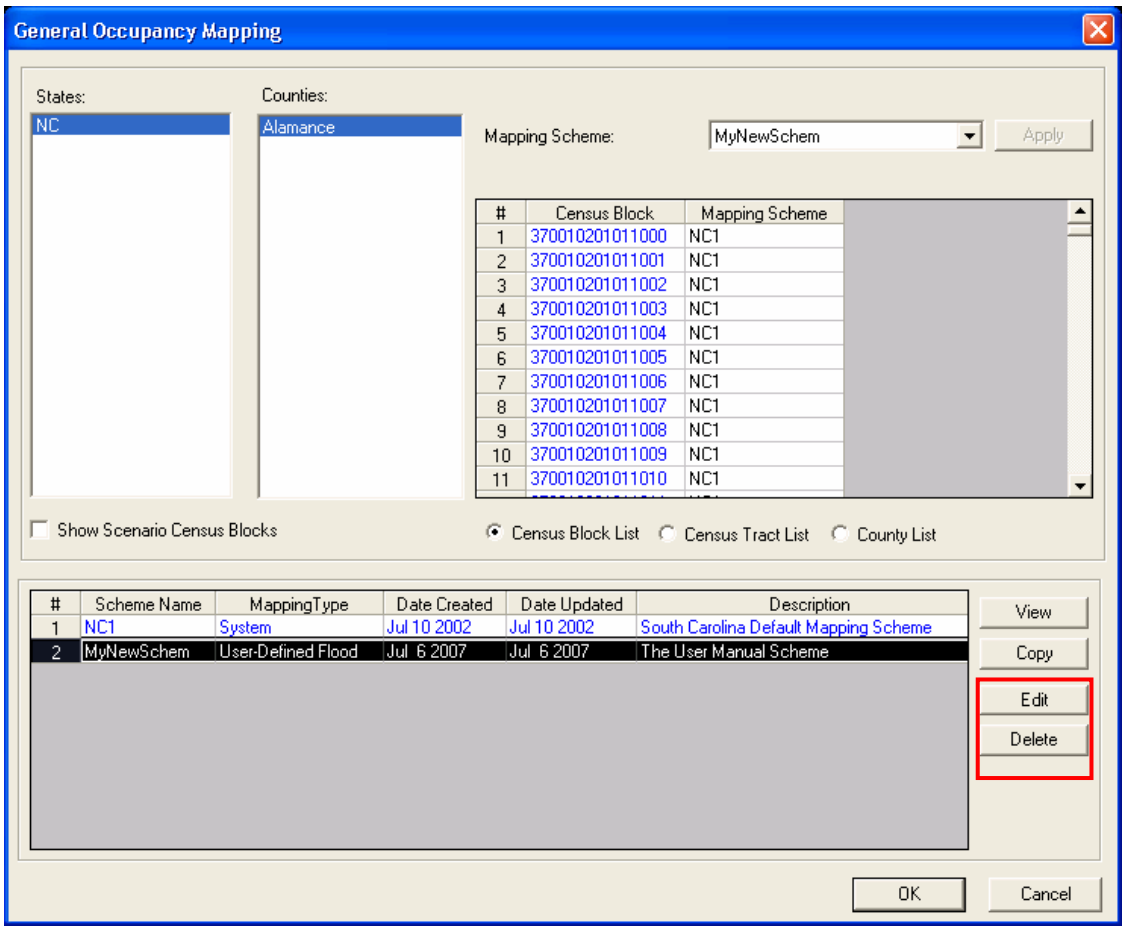


Figure 3.18 General Occupancy Mapping with User Defined Mapping Scheme

When the user created mapping scheme is selected (as seen in Figure 3.18) the command buttons **Edit** and **Delete** (red box) are enabled. The user can use the **Edit** button to open a dialog similar to that seen in Figure 3.16 except the field text will be black and the user is allowed to edit the information and change the mapping scheme. Please note that the user is not allowed to edit the specific occupancy identification (e.g., RES1) and this text remains blue.

3.2.2.7 Flood Specific Occupancy Mapping

Flood specific occupancy mapping is an example of a hazard specific default data parameter included with the **HAZUS** model. The flood specific occupancy mapping "maps" the specific occupancy categories for buildings, such as *RES1* and *RES2*, to physical building characteristics that affect flood damage. Specifically, these physical building characteristics include the type of building foundation and the height of the building's first floor above grade. There are three default mapping schemes that come with the **HAZUS** program. Figure 3.19, below, indicates which of the three default schemes has been assigned to each census block in your study region. For the example region, the default scheme *RiverineDflt* has been assigned to all census blocks.

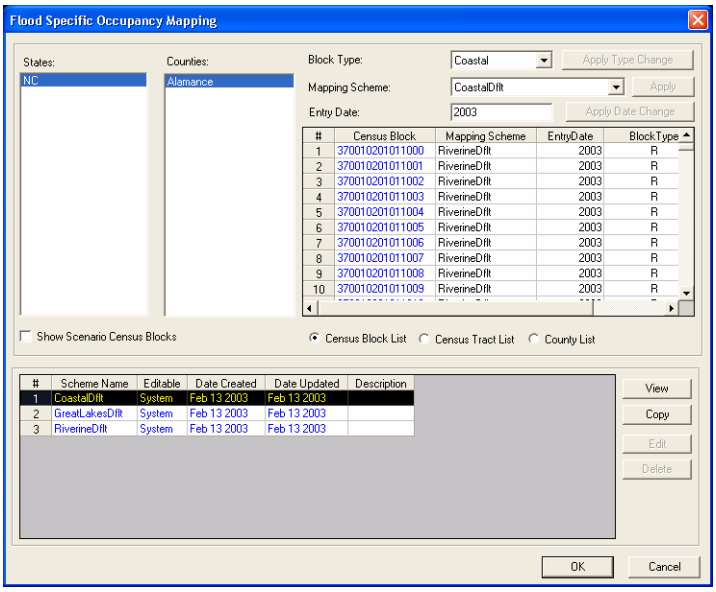


Figure 3.19 Flood Specific Occupancy Mapping Overview

If you select the *RiverineDflt* row in the *Flood Building Mapping* window, and press **View**, the window shown in Figure 3.20 will appear. Select any specific occupancy classification, such as COM1, to view the default assumptions for structures built before and after a Flood Insurance Rate Map (FIRM) was made for the community (i.e., Pre-FIRM and Post-FIRM).

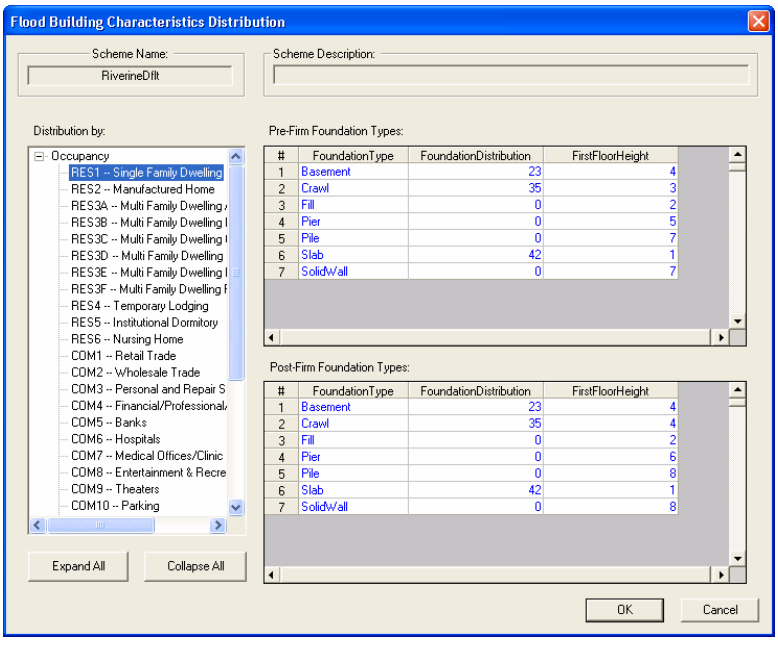


Figure 3.20 Sample Riverine Flood Specific Occupancy Mapping

If the user selects either the *CoastalDflt* or the *GreatLakesDflt* row in the Flood Building Mapping window, and press **View**, the window shown in Figure 3.21 will appear. Selecting any specific occupancy classification, such as COM1, and the dialog seen in Figure 3.21 will appear. While similar in many ways to the Riverine Occupancy Mapping scheme, the Coastal and Great Lakes Occupancy Mapping Scheme are different in the Post-FIRM classification due to the identification of A-Zone and V-Zone designations in coastal areas. The flood model has chosen to address the Great Lakes with a V-Zone area to account for the possibility that wave affects on structures near the shorelines is a hazard some communities may want to analyze. While this is different than the current FEMA mapping methodology, the Flood Oversight Committee approved the approach.

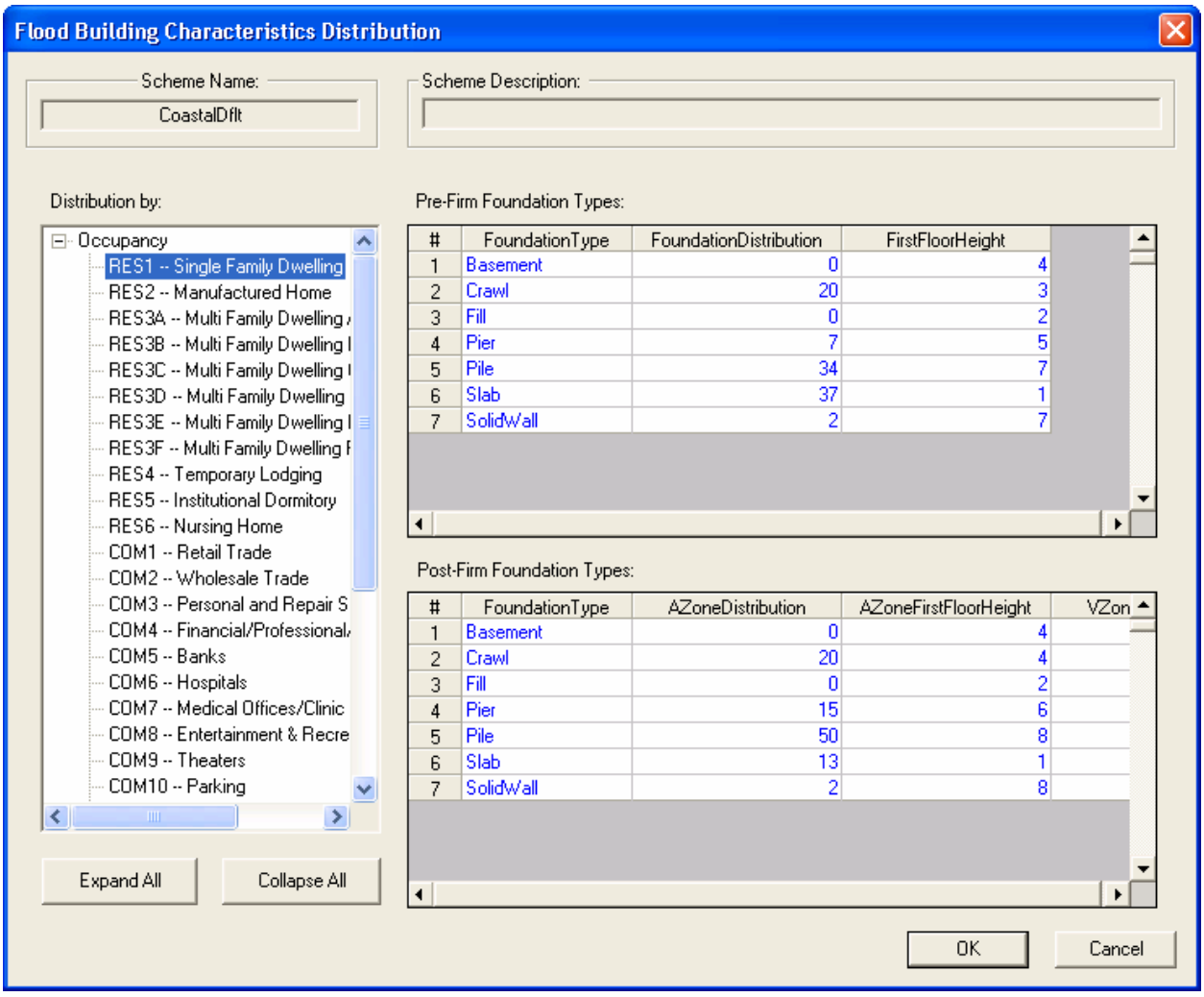
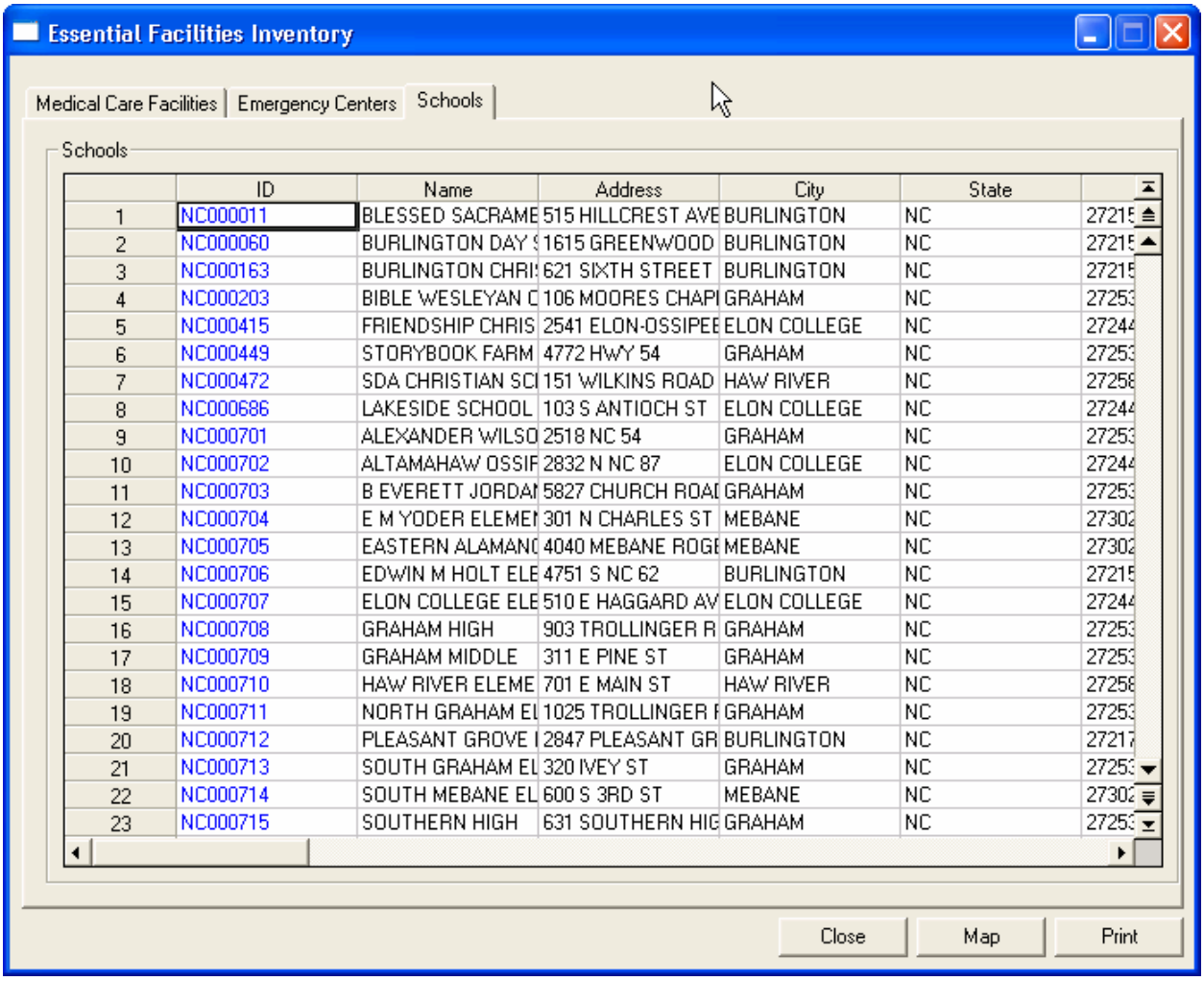


Figure 3.21 Sample Coastal and Great Lakes Flood Specific Occupancy Mapping

3.2.3 Essential Facilities

Most of the essential facility inventory data is common to all three hazards. The only hazard-specific data is the specific building type, if that information is available.



	ID	Name	Address	City	State	
1	NC000011	BLESSED SACRAME	515 HILLCREST AVE	BURLINGTON	NC	27215
2	NC000060	BURLINGTON DAY S	1615 GREENWOOD	BURLINGTON	NC	27215
3	NC000163	BURLINGTON CHRI	621 SIXTH STREET	BURLINGTON	NC	27215
4	NC000203	BIBLE WESLEYAN C	106 MOORES CHAPI	GRAHAM	NC	27253
5	NC000415	FRIENDSHIP CHRIS	2541 ELON-OSSIPEE	ELON COLLEGE	NC	27244
6	NC000449	STORYBOOK FARM	4772 HWY 54	GRAHAM	NC	27253
7	NC000472	SDA CHRISTIAN SCI	151 WILKINS ROAD	HAW RIVER	NC	27258
8	NC000686	LAKESIDE SCHOOL	103 S ANTIOCH ST	ELON COLLEGE	NC	27244
9	NC000701	ALEXANDER WILSO	2518 NC 54	GRAHAM	NC	27253
10	NC000702	ALTAMAHAW OSSIF	2832 N NC 87	ELON COLLEGE	NC	27244
11	NC000703	B EVERETT JORDAN	5827 CHURCH ROAD	GRAHAM	NC	27253
12	NC000704	E M YODER ELEMEN	301 N CHARLES ST	MEBANE	NC	27302
13	NC000705	EASTERN ALAMANC	4040 MEBANE ROGE	MEBANE	NC	27302
14	NC000706	EDWIN M HOLT ELE	4751 S NC 62	BURLINGTON	NC	27215
15	NC000707	ELON COLLEGE ELE	510 E HAGGARD AV	ELON COLLEGE	NC	27244
16	NC000708	GRAHAM HIGH	903 TROLLINGER R	GRAHAM	NC	27253
17	NC000709	GRAHAM MIDDLE	311 E PINE ST	GRAHAM	NC	27253
18	NC000710	HAW RIVER ELEME	701 E MAIN ST	HAW RIVER	NC	27258
19	NC000711	NORTH GRAHAM EL	1025 TROLLINGER R	GRAHAM	NC	27253
20	NC000712	PLEASANT GROVE I	2847 PLEASANT GR	BURLINGTON	NC	27217
21	NC000713	SOUTH GRAHAM EL	320 IVEY ST	GRAHAM	NC	27253
22	NC000714	SOUTH MEBANE EL	600 S 3RD ST	MEBANE	NC	27302
23	NC000715	SOUTHERN HIGH	631 SOUTHERN HIG	GRAHAM	NC	27253

Figure 3.22 Essential Facilities Inventory Data Browser

3.2.4 High Potential Loss Facilities

The High Potential Loss Facilities (HPLF) browser allows you to view and map the default database for your study region. Damage and loss are not computed for HPLF's in the present version of the Flood Model.

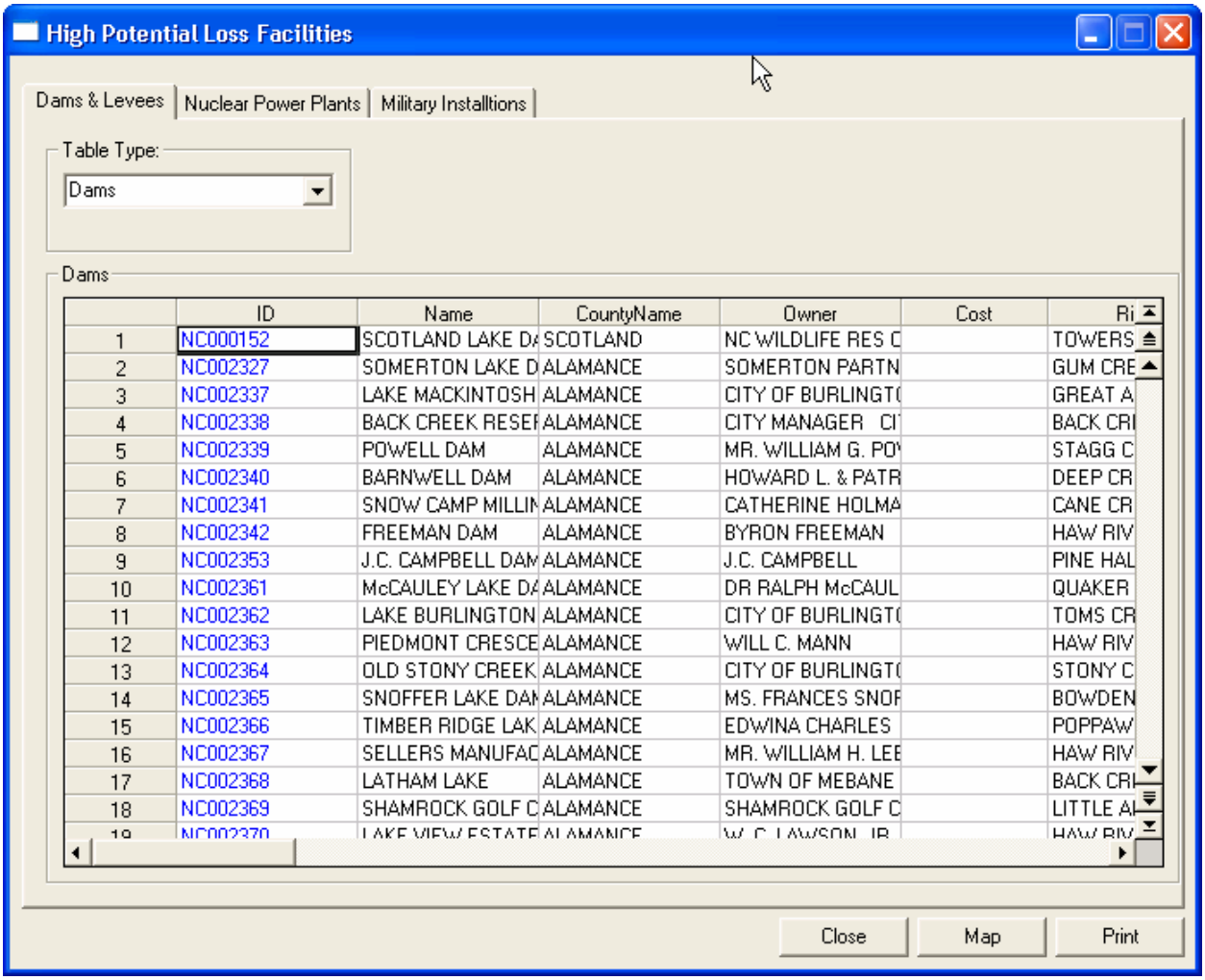

High Potential Loss Facilities
Dams & Levees
Nuclear Power Plants
Military Installtions
Table Type:
Dams
Dams
ID
Name
CountyName
Owner
Cost
Ri
1 NC000152 SCOTLAND LAKE DA SCOTLAND NC WILDLIFE RES C TOWERS
2 NC002327 SOMERTON LAKE D ALAMANCE SOMERTON PARTN GUM CRE
3 NC002337 LAKE MACKINTOSH ALAMANCE CITY OF BURLINGT GREAT A
4 NC002338 BACK CREEK RESEF ALAMANCE CITY MANAGER CI BACK CRI
5 NC002339 POWELL DAM ALAMANCE MR. WILLIAM G. PO STAGG C
6 NC002340 BARNWELL DAM ALAMANCE HOWARD L. & PATR DEEP CR
7 NC002341 SNOW CAMP MILLI ALAMANCE CATHERINE HOLMA CANE CR
8 NC002342 FREEMAN DAM ALAMANCE BYRON FREEMAN HAW RIV
9 NC002353 J.C. CAMPBELL DAM ALAMANCE J.C. CAMPBELL PINE HAL
10 NC002361 McCAULEY LAKE DA ALAMANCE DR RALPH McCAUL QUAKER
11 NC002362 LAKE BURLINGTON ALAMANCE CITY OF BURLINGT TOMS CR
12 NC002363 PIEDMONT CRESCE ALAMANCE WILL C. MANN HAW RIV
13 NC002364 OLD STONY CREEK ALAMANCE CITY OF BURLINGT STONY C
14 NC002365 SNOFFER LAKE DAI ALAMANCE MS. FRANCES SNOF BOWDEN
15 NC002366 TIMBER RIDGE LAK ALAMANCE EDWINA CHARLES POPPAW
16 NC002367 SELLERS MANUFAC ALAMANCE MR. WILLIAM H. LEE HAW RIV
17 NC002368 LATHAM LAKE ALAMANCE TOWN OF MEBANE BACK CRI
18 NC002369 SHAMROCK GOLF C ALAMANCE SHAMROCK GOLF C LITTLE AL
Close
Map
Print

Figure 3.23 High Potential Loss Facilities Inventory Data Browser

3.2.5 User-Defined Facilities

User-Defined Facilities (UDFs) are any individual buildings that you may wish to add to the study region. The Flood Model outputs damage state probabilities for each UDF. UDFs default to the General Building Stock mapping schemes defined for the census tracts in which they are located. However, you can define a specific building type and a set of wind building characteristics if such information is available for an individual UDF.

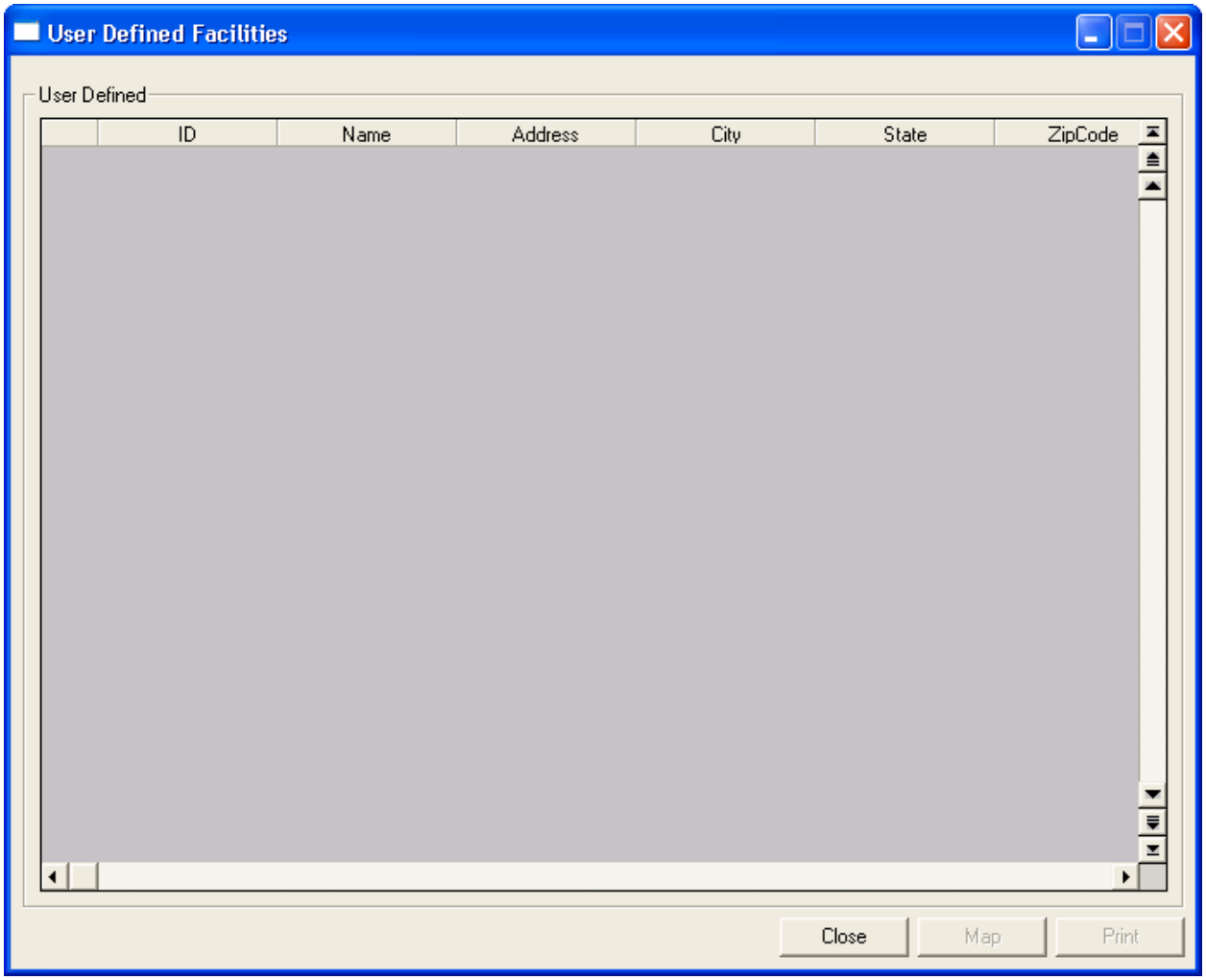


Figure 3.24 User Defined Facilities Browser

3.2.6 Transportation Systems

The Transportation Systems browser allows you to view and map the default database for your study region.

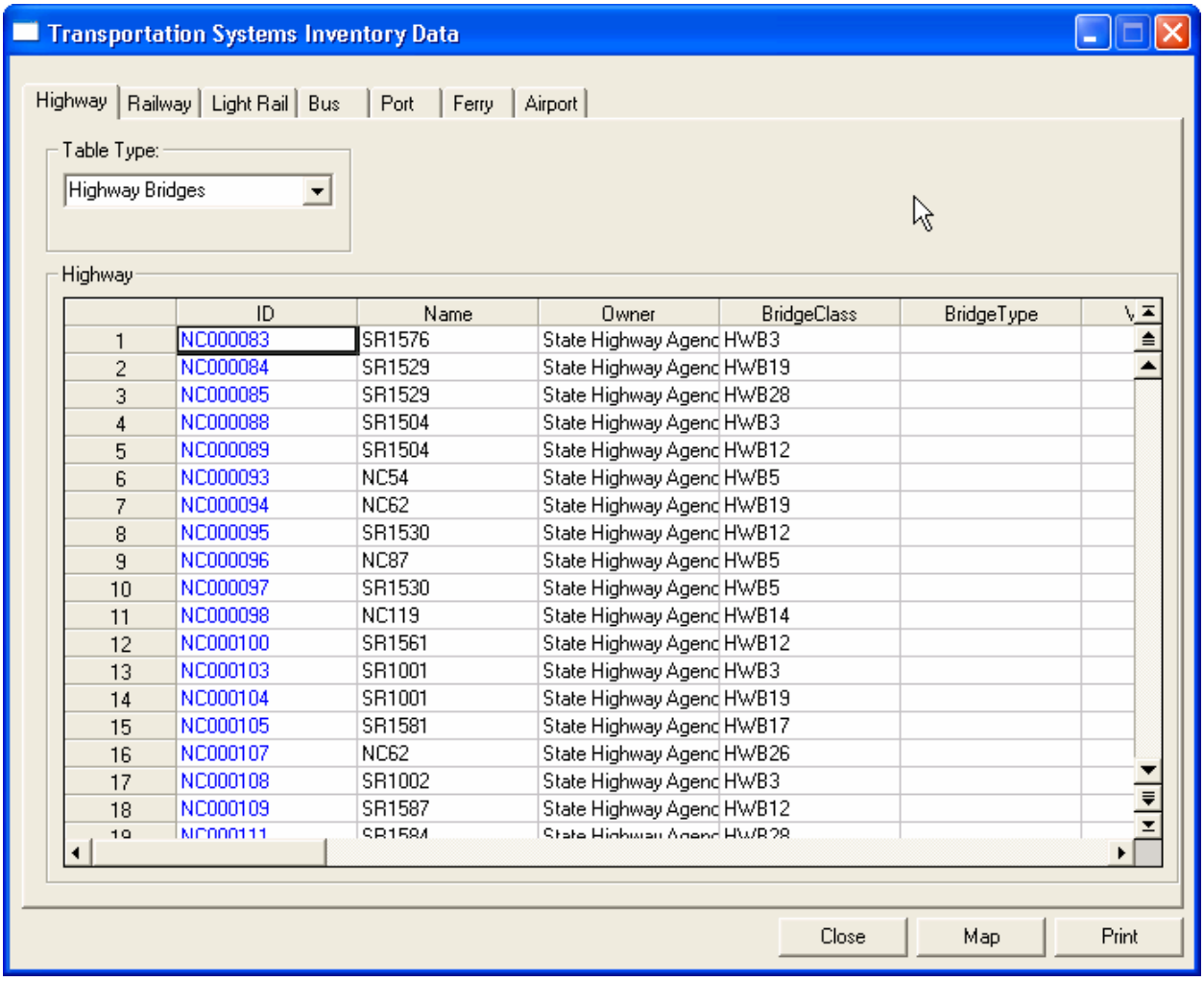

Transportation Systems Inventory Data
Highway
Railway
Light Rail
Bus
Port
Ferry
Airport
Table Type:
Highway Bridges
Highway
ID
Name
Owner
BridgeClass
BridgeType
1 NC000083 SR1576 State Highway Agenc HWB3
2 NC000084 SR1529 State Highway Agenc HWB19
3 NC000085 SR1529 State Highway Agenc HWB28
4 NC000088 SR1504 State Highway Agenc HWB3
5 NC000089 SR1504 State Highway Agenc HWB12
6 NC000093 NC54 State Highway Agenc HWB5
7 NC000094 NC62 State Highway Agenc HWB19
8 NC000095 SR1530 State Highway Agenc HWB12
9 NC000096 NC87 State Highway Agenc HWB5
10 NC000097 SR1530 State Highway Agenc HWB5
11 NC000098 NC119 State Highway Agenc HWB14
12 NC000100 SR1561 State Highway Agenc HWB12
13 NC000103 SR1001 State Highway Agenc HWB3
14 NC000104 SR1001 State Highway Agenc HWB19
15 NC000105 SR1581 State Highway Agenc HWB17
16 NC000107 NC62 State Highway Agenc HWB26
17 NC000108 SR1002 State Highway Agenc HWB3
18 NC000109 SR1587 State Highway Agenc HWB12
Close
Map
Print

Figure 3.25 Transportation Systems Data Browser

3.2.7 Utility Systems

The Utilities Systems browser allows you to view and map the default database for your study region.

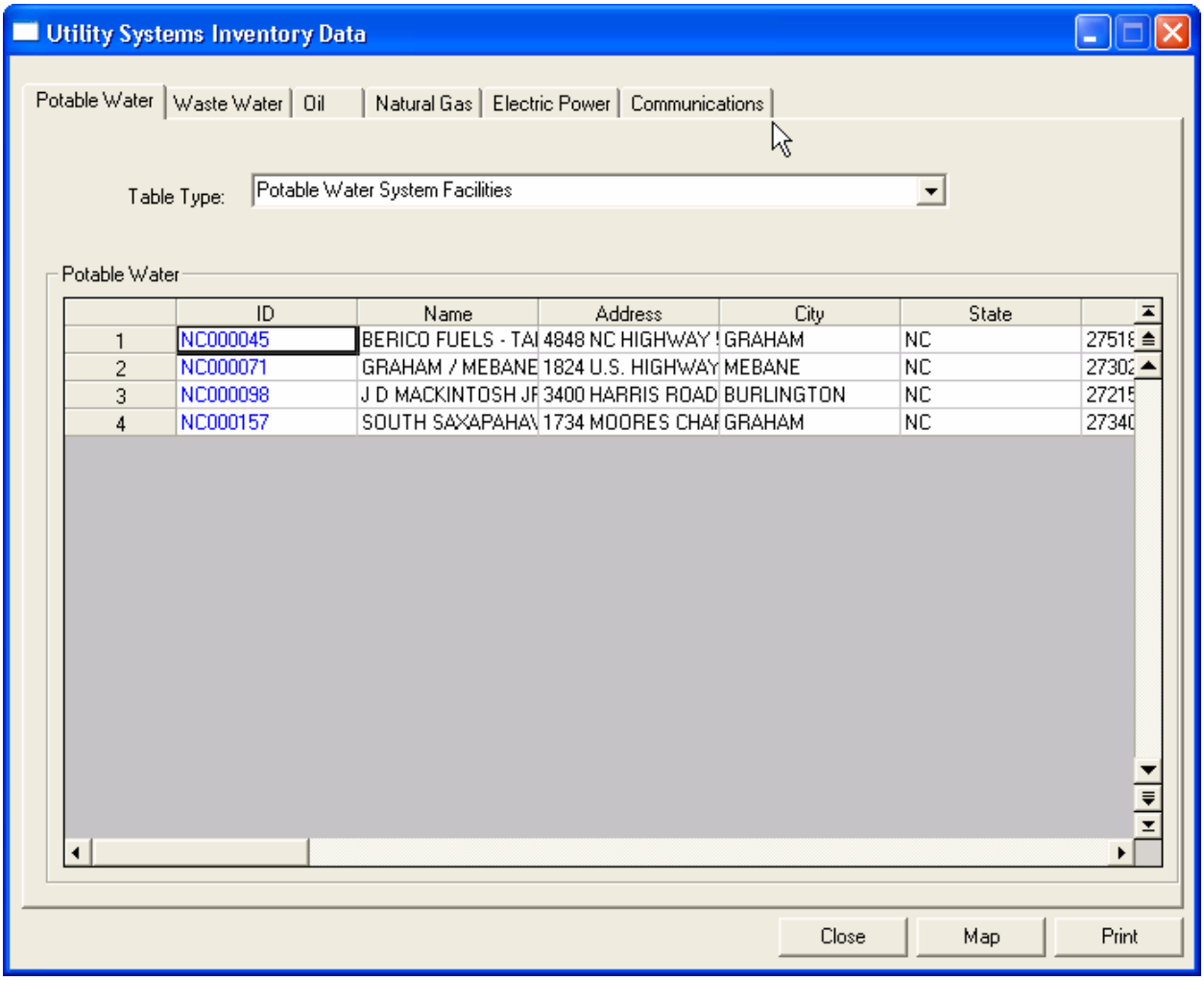
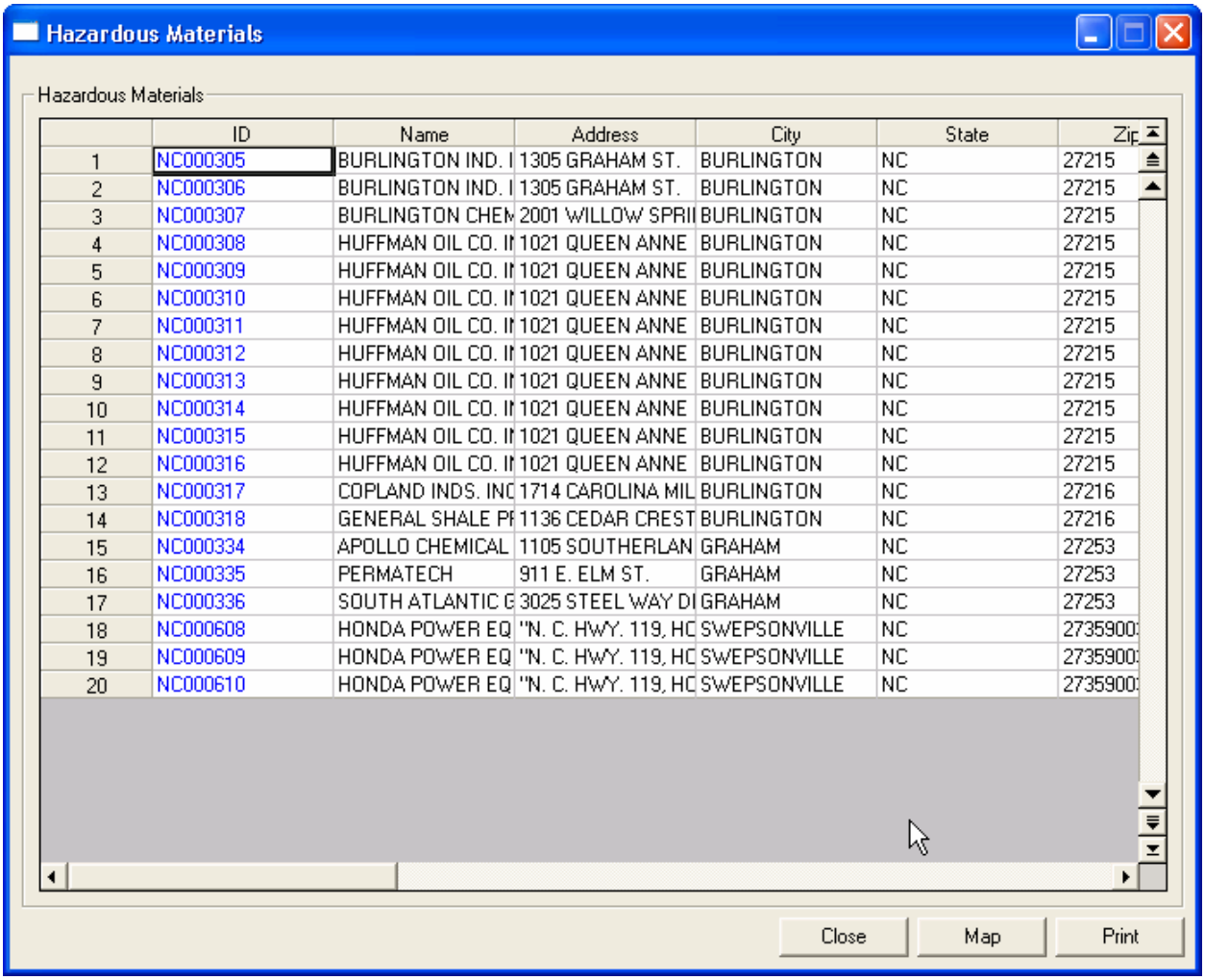


Figure 3.26 Utility Systems Data Browser

3.2.8 Hazardous Materials

The Hazardous Materials browser allows you to view and map the default database for your study region. Damage and loss are not computed for Hazardous Materials sites in the present version of the Flood Model.

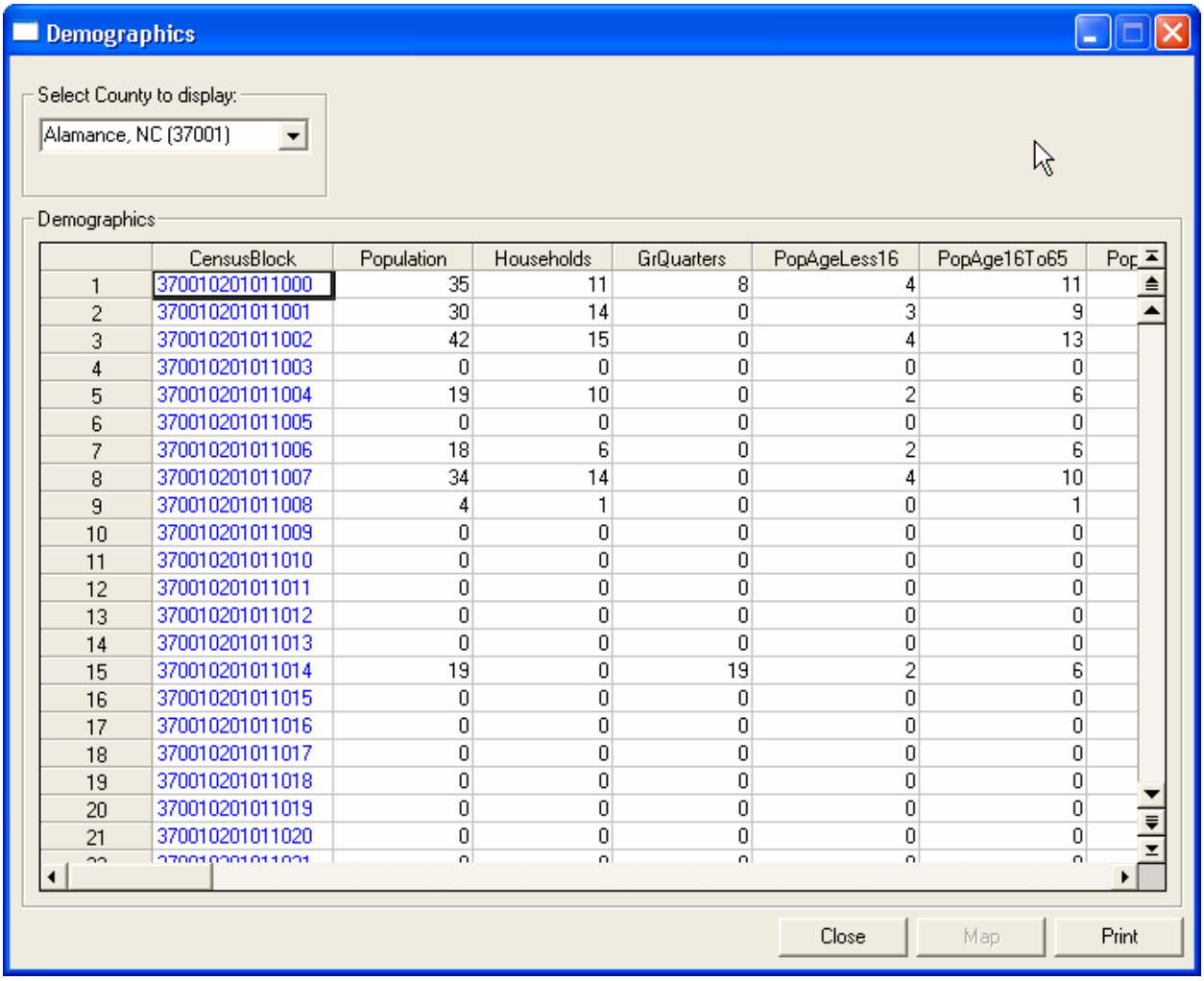


	ID	Name	Address	City	State	Zip
1	NC000305	BURLINGTON IND. I	1305 GRAHAM ST.	BURLINGTON	NC	27215
2	NC000306	BURLINGTON IND. I	1305 GRAHAM ST.	BURLINGTON	NC	27215
3	NC000307	BURLINGTON CHEM	2001 WILLOW SPRI	BURLINGTON	NC	27215
4	NC000308	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
5	NC000309	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
6	NC000310	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
7	NC000311	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
8	NC000312	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
9	NC000313	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
10	NC000314	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
11	NC000315	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
12	NC000316	HUFFMAN OIL CO. I	1021 QUEEN ANNE	BURLINGTON	NC	27215
13	NC000317	COPLAND INDS. INC	1714 CAROLINA MIL	BURLINGTON	NC	27216
14	NC000318	GENERAL SHALE PF	1136 CEDAR CREST	BURLINGTON	NC	27216
15	NC000334	APOLLO CHEMICAL	1105 SOUTHERLAN	GRAHAM	NC	27253
16	NC000335	PERMATECH	911 E. ELM ST.	GRAHAM	NC	27253
17	NC000336	SOUTH ATLANTIC G	3025 STEEL WAY DI	GRAHAM	NC	27253
18	NC000608	HONDA POWER EQ	"N. C. HWY. 119, HC	SWEPSONVILLE	NC	2735900
19	NC000609	HONDA POWER EQ	"N. C. HWY. 119, HC	SWEPSONVILLE	NC	2735900
20	NC000610	HONDA POWER EQ	"N. C. HWY. 119, HC	SWEPSONVILLE	NC	2735900

Figure 3.27 Hazardous Materials Data Browser

3.2.9 Demographics

The Demographics browser allows you to view and map the default database for your study region. Demographics data are used in the shelter requirements methodology.



	CensusBlock	Population	Households	GrQuarters	PopAgeLess16	PopAge16To65	Pop
1	370010201011000	35	11	8	4	11	
2	370010201011001	30	14	0	3	9	
3	370010201011002	42	15	0	4	13	
4	370010201011003	0	0	0	0	0	
5	370010201011004	19	10	0	2	6	
6	370010201011005	0	0	0	0	0	
7	370010201011006	18	6	0	2	6	
8	370010201011007	34	14	0	4	10	
9	370010201011008	4	1	0	0	1	
10	370010201011009	0	0	0	0	0	
11	370010201011010	0	0	0	0	0	
12	370010201011011	0	0	0	0	0	
13	370010201011012	0	0	0	0	0	
14	370010201011013	0	0	0	0	0	
15	370010201011014	19	0	19	2	6	
16	370010201011015	0	0	0	0	0	
17	370010201011016	0	0	0	0	0	
18	370010201011017	0	0	0	0	0	
19	370010201011018	0	0	0	0	0	
20	370010201011019	0	0	0	0	0	
21	370010201011020	0	0	0	0	0	

Figure 3.28 Demographics Data Browser

3.2.10 Agriculture Products

This dataset is unique to the flood model and allows the user to gain some insight into the potential losses that could occur due to flooding of planted cropland. Selecting Agriculture Products on the Inventory menu opens the dialog seen in Figure 3.29. The agriculture product data was developed using national datasets that include merged GIS data for the County, Hydraulic Unit Codes (drainage basins), and Land Use and Land Cover. This allows the flood model to define the agriculture products data at the county level as well as smaller sub-county regions. These smaller sub-county regions do not correlate with the census block or tract

boundaries, but they do correlate with the county boundary. As shown in the figure, the user is shown the county summary and can select a radio button to view the sub-county polygons.

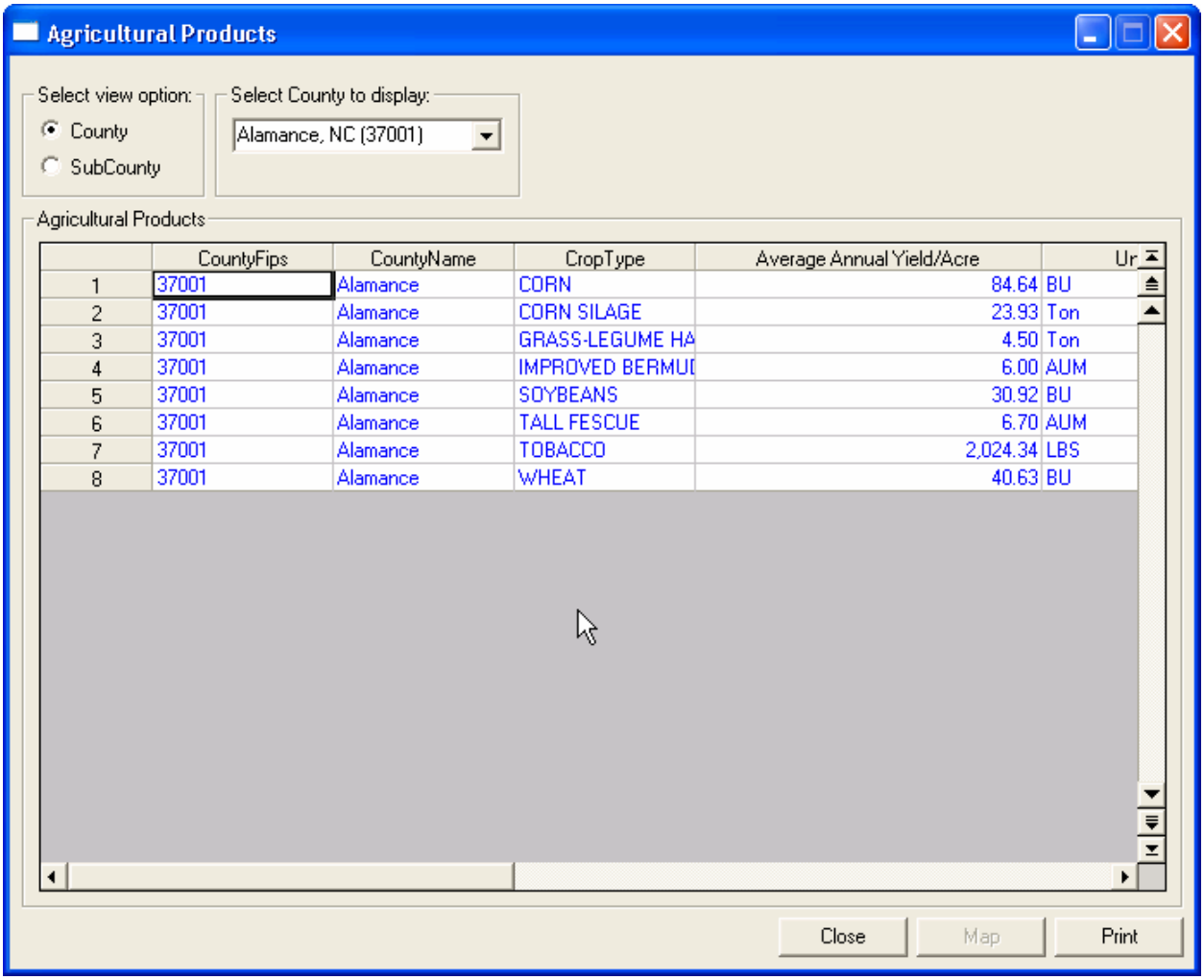


Figure 3.29 Agriculture Products County Level View

Selecting the radio button displays the dialog Figure 3.30 and the user is free to view the agriculture products within the sub-county areas. The user is also allowed to add, remove and edit the crops within the sub-county regions. The user cannot change the sub-county polygons, but can remove crops, add crops, modify the output, and the crop value as necessary to meet local conditions. As will be discussed further in the discussion on the damage functions, only the crop types previously identified have damage functions.

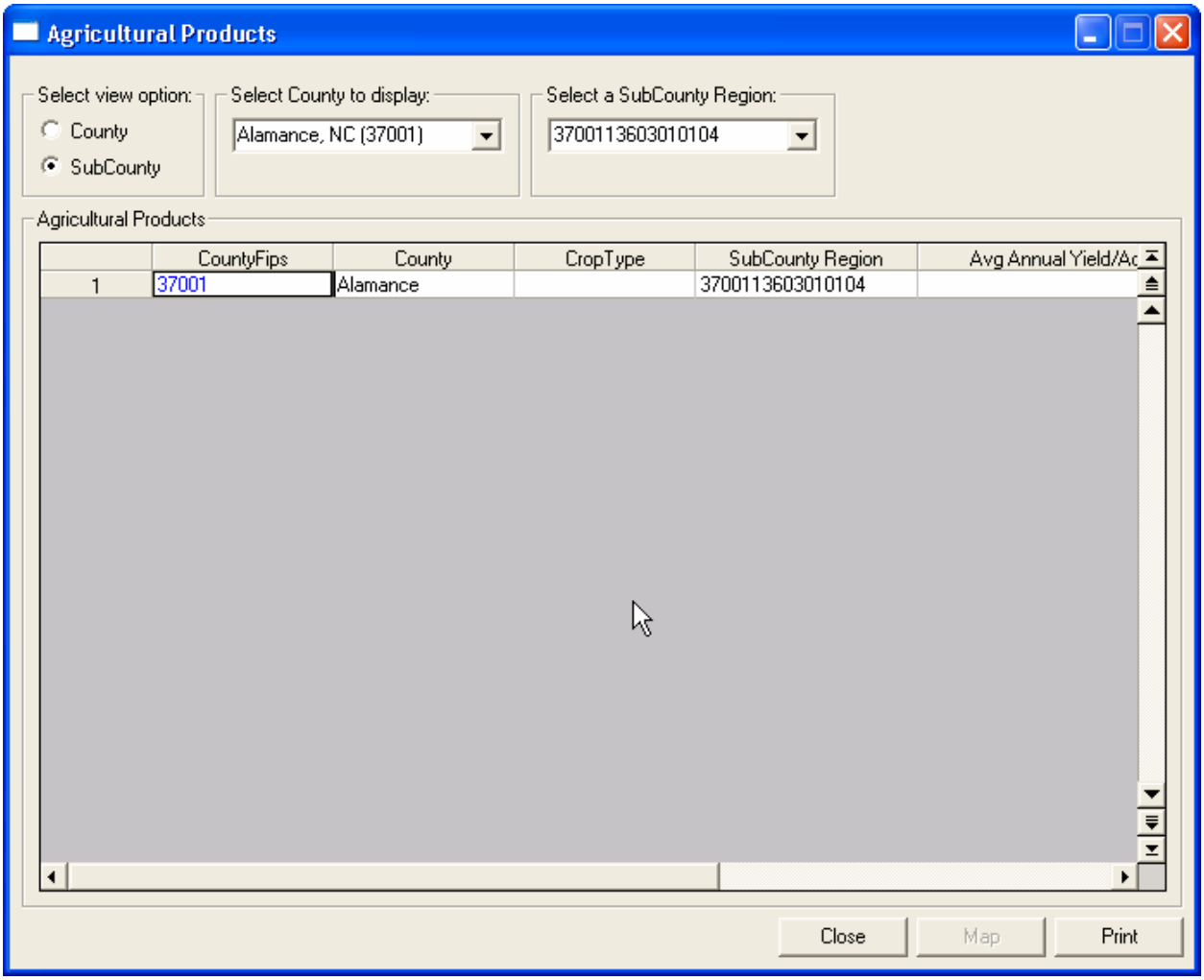
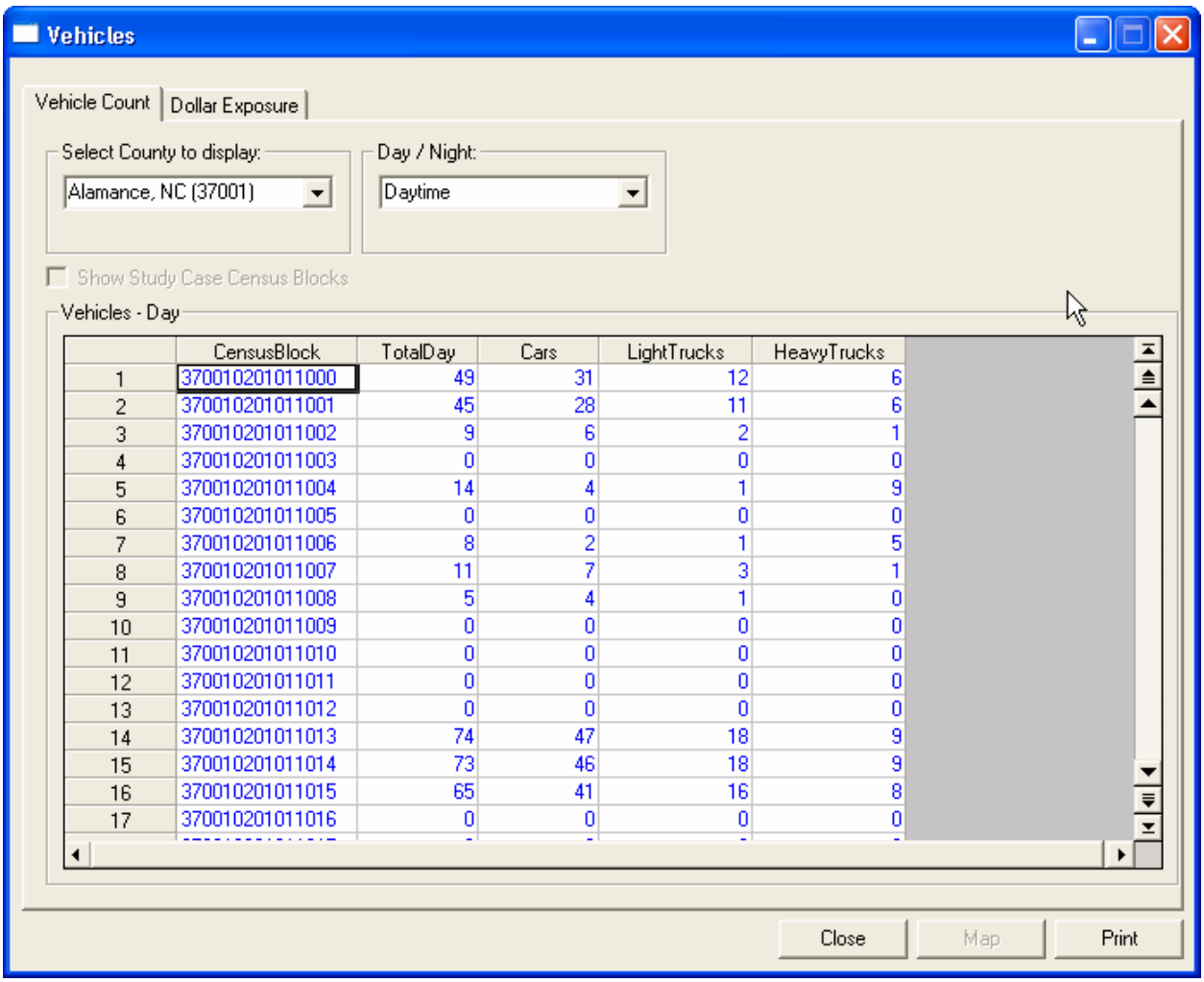


Figure 3.30 Agriculture Products Sub-County View

3.2.11 Vehicle Data

Another dataset unique to the flood model, the vehicle inventory was developed to allow the user to assess the additional losses possible due to vehicles remaining within the flood areas. The data was developed using the square footage occupancy data for the various occupancy classes. The methodology is similar to that used by Metropolitan Planning Organizations to identify parking and traffic patterns for planned development and provides an appropriate approximation of the number of vehicles each occupancy classification will typically have nearby. Because vehicles are used by their owners throughout the day, the flood model has identified two "snapshots" of time, the nighttime, when passenger vehicles are more likely to be concentrated near residential structures and commercial industrial vehicles are more likely to remain in commercial areas, and the daytime where the commercial and industrial areas will see an influx of all varieties of vehicles.

Selection of Vehicles on the Inventory menu will open a dialog as seen in Figure 3.31 below.



	CensusBlock	TotalDay	Cars	LightTrucks	HeavyTrucks
1	370010201011000	49	31	12	6
2	370010201011001	45	28	11	6
3	370010201011002	9	6	2	1
4	370010201011003	0	0	0	0
5	370010201011004	14	4	1	9
6	370010201011005	0	0	0	0
7	370010201011006	8	2	1	5
8	370010201011007	11	7	3	1
9	370010201011008	5	4	1	0
10	370010201011009	0	0	0	0
11	370010201011010	0	0	0	0
12	370010201011011	0	0	0	0
13	370010201011012	0	0	0	0
14	370010201011013	74	47	18	9
15	370010201011014	73	46	18	9
16	370010201011015	65	41	16	8
17	370010201011016	0	0	0	0

Figure 3.31 Daytime Vehicle Count

Selection of the dollar exposure tab allows the user to view the estimated value of the vehicles within any given census block. The vehicle valuation is based on the distribution of new and used vehicles provided by each states Department of Motor Vehicles and the average sale price of these vehicles. The flood model looks at passenger cars, light trucks (including SUVs), and heavy trucks (commercial/industrial vehicles including 18-wheelers). In this version of the flood model, the vehicle data is not editable, but in future versions, this data will be editable.

3.2.12 View Classification

The View Classification browser allows you to view definitions of the classification categories.

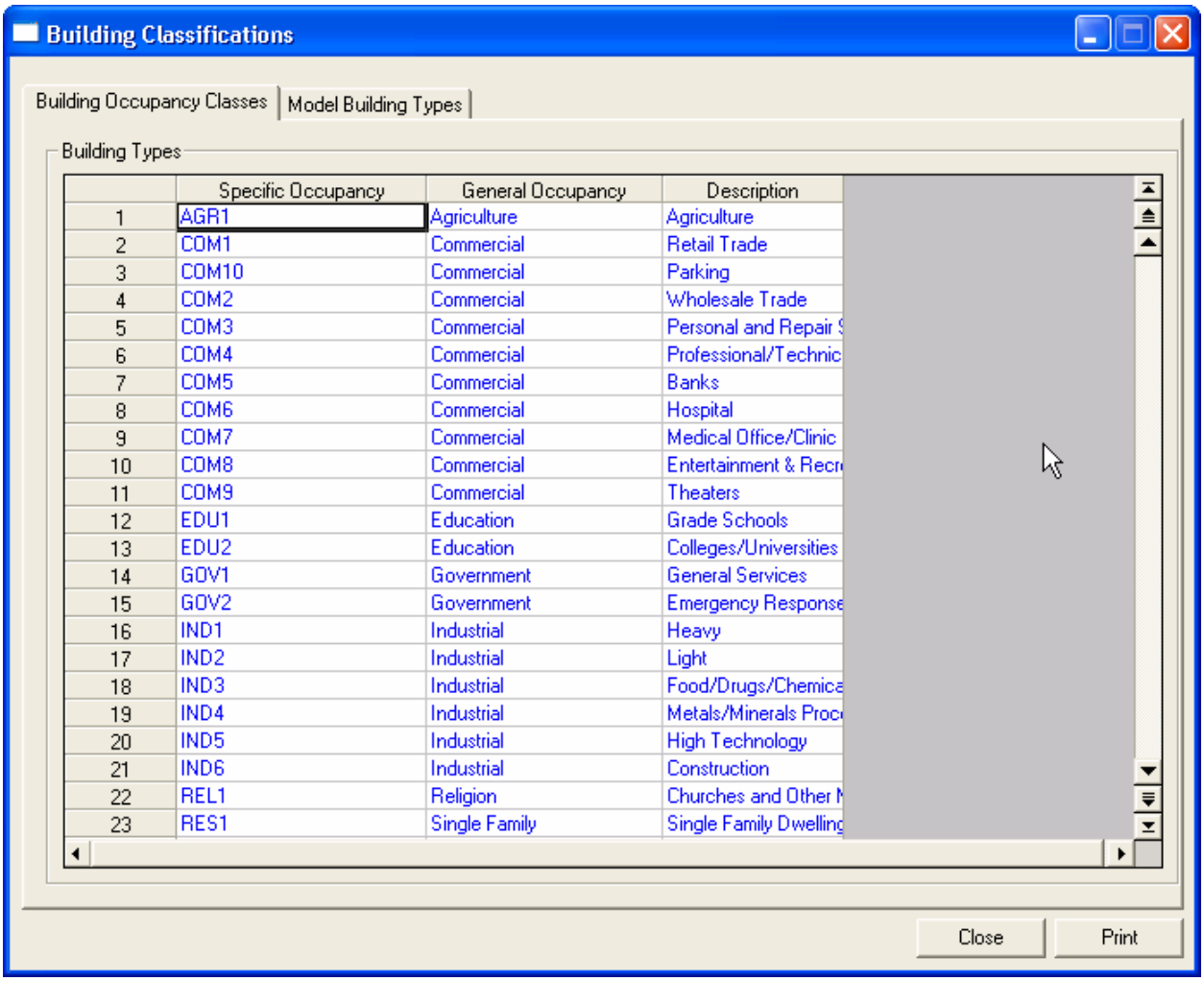


Figure 3.32 View Classification Browser

3.2.13 Showing Tabular Data on Map

Tabular data can be shown on the study region map in addition to graphic form. To map data, simply open the window that contains the data you are interested in. Highlight the column you would like to map by single clicking on the column header as shown in Figure 3.33. You will notice that the **Map** button at the bottom of the window now becomes active. Press the **Map** button and a thematic map of the data is automatically developed as seen in Figure 3.34.

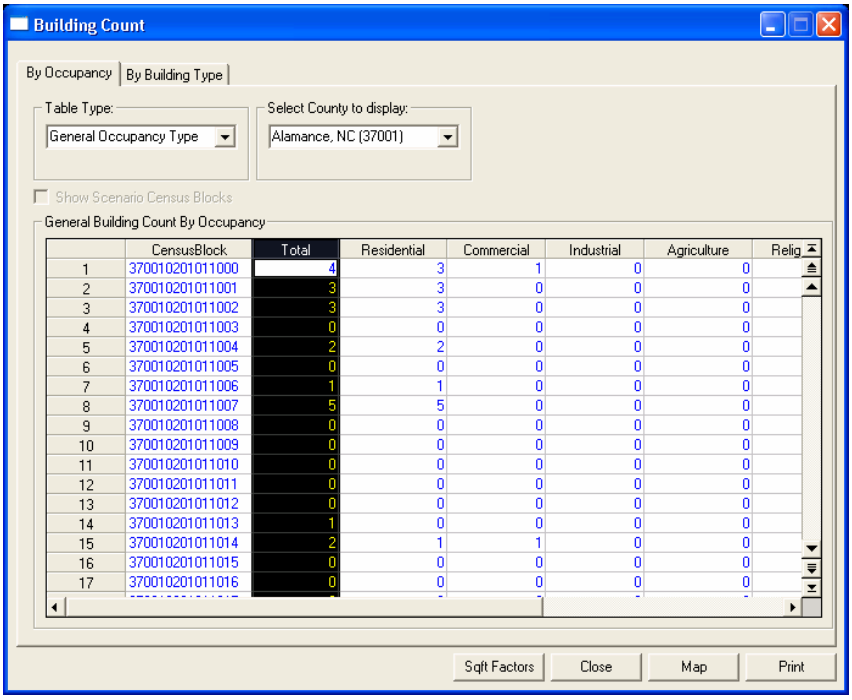


Figure 3.33 Selecting Data to Map

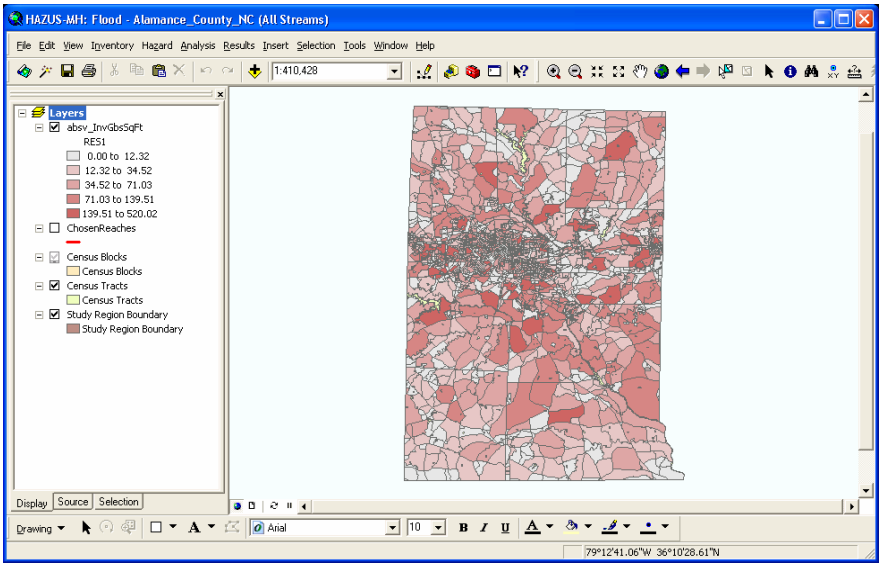


Figure 3.34 Mapping Tabular Data

Mapping any inventory data, even with the scenario census blocks box checked, will result in mapping all study region census blocks. HAZUS is performing as designed, the scenario census blocks is available primarily for browser editing, not mapping.

3.2.14 Printing Tabular Data

Tabular data can be printed by clicking the **Print** button at the bottom of the display window, as seen in Figure 3.35 (circled).

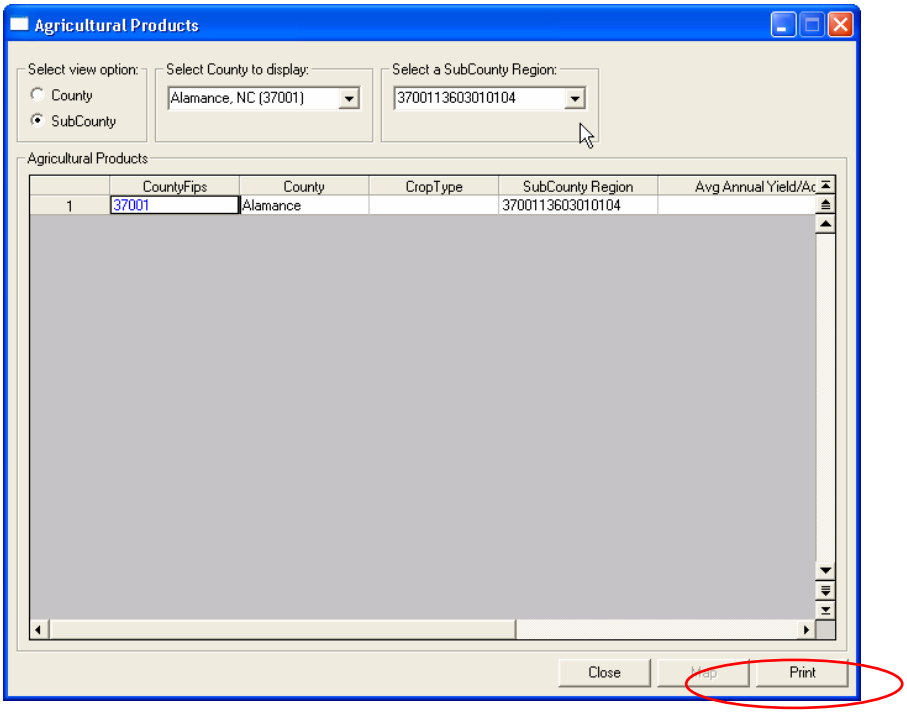


Figure 3.35 Printing Tabular Data

3.3 Defining the Flood Hazard

A key step in running a **HAZUS** analysis is defining the flood hazard for your study region. This involves importing topography data, calculating stream networks for riverine hazard, and defining the flooding hazard you wish to analyze. The analysis can be conducted for riverine flood hazard, coastal flood hazard, or both.

Table 3.1 shows the analysis process for the flood hazard. When performing a combined analysis (riverine and coastal) the user is required to perform all of the steps noted:

Table 3.1 HAZUS Menu Items

HAZUS Flood Hazard Analysis Process	
Riverine Hazard	**Coastal Hazard**
Define Terrain (Input DEM)	
Generate Stream Network	No Equivalent
Create New Scenario	
Select Reaches	Select Shorelines
Hydrologic Analysis	No Equivalent
No Equivalent	Characterize Shoreline
Compute Flood Hazard (Hydraulics analysis) for suite, specific return period, specific discharge, annualized return periods	Compute Flood Hazard (frontal dune erosion, WHAFIS, wave runup, zone determination) for suite, single return period, annualized return periods
Develop Flood depth grid (completed base hazard analysis)	
Optional Hazard Analysis Perform What If – Levee Assessment Perform What If – Flow Regulation Perform What If – Velocity grid	Optional Hazard Analysis Perform What If – Long-term Erosion Perform What If - Shore Protection

3.3.1 Selecting the Flood Hazard Type

The riverine and coastal hazards have different requirements in terms of the development of the hazard and the digital elevation data required to support the analysis. To prevent the user from having to carry the penalty of digital terrain data that is not required and to enable only those menu items needed to support their hazard of choice, the first menu item on the Hazard Menu requires the user to select the hazard for which they want to analyze within their study region. The selection dialog can be seen in Figure 3.36 below.

Figure 3.36 Flood Hazard Type Selection

The user should think carefully about which hazard type (or both) they are interested in analyzing as the selection will drive the entire hazard assessment and changing the selection will change the DEM requirement and prevent the user from accessing some of the menu items.

For example, selection of the *Riverine only* button will require a DEM that covers both the study region and all the watersheds that intersect that study region and will require the user to develop a stream network before other hazard menu items are enabled.

3.3.2 Defining Topography

As might be anticipated, topography is the most critical element to the flood model. The flood model has developed an approach to simplify the effort to obtain digital elevation data and bring these data into the model. Primarily, the data extent is identified and the user is asked to download and point the flood model to the resulting ArcGIS grid dataset.

For this section on running a default analysis, we will examine the process of importing DEM data from the U.S. Geological Survey (USGS) web page.

The Level 2 user should note that in some cases they will need to bring in a DEM layer sufficient to meet the extent requirements defined for Level 1 users since there is always the possibility that the user may ask the flood model to extrapolate their FIT input data and exceed the flood boundaries they brought in.

3.3.3 Download DEM Data from USGS

The USGS website contains downloadable data from the National Elevation Dataset (NED). The NED is a digital data set available from USGS that provides national elevation data in a downloadable form with consistent datum, elevation unit, and projection. This dataset has been chosen to be the default data for the Flood Model. This does not preclude a user from bringing in his or her own DEM.

To import DEM data, first select the *Hazard* menu and the *User Data* submenu, as shown in Figure 3.37. A window will pop up with three tabs: DEM, FIT, and Depth Grid. In the DEM tab, select "Determine required DEM extent" button, as shown in Figure 3.38.

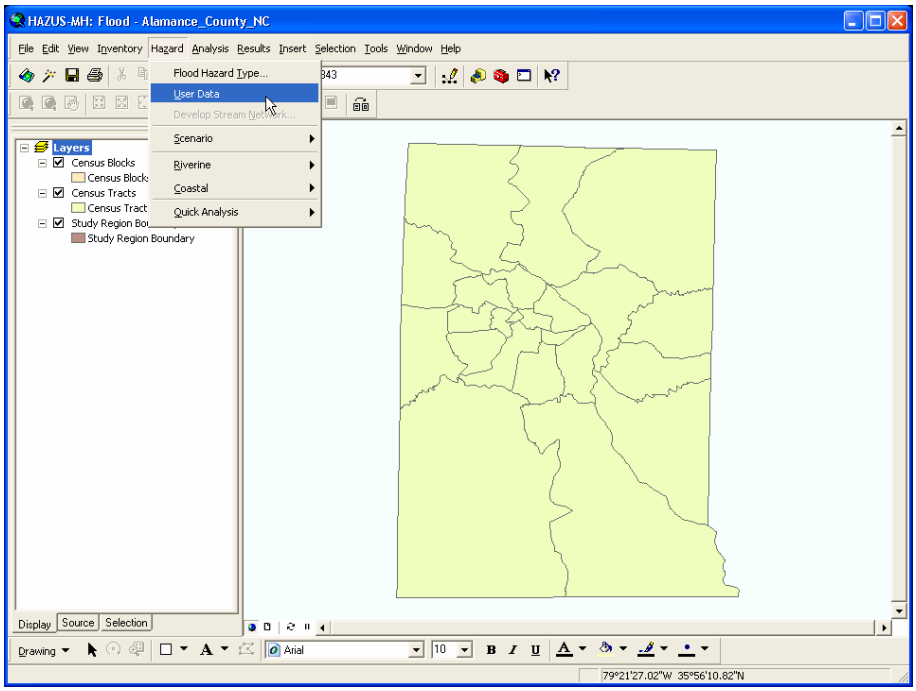


Figure 3.37 Hazard and User Data Paths Menus

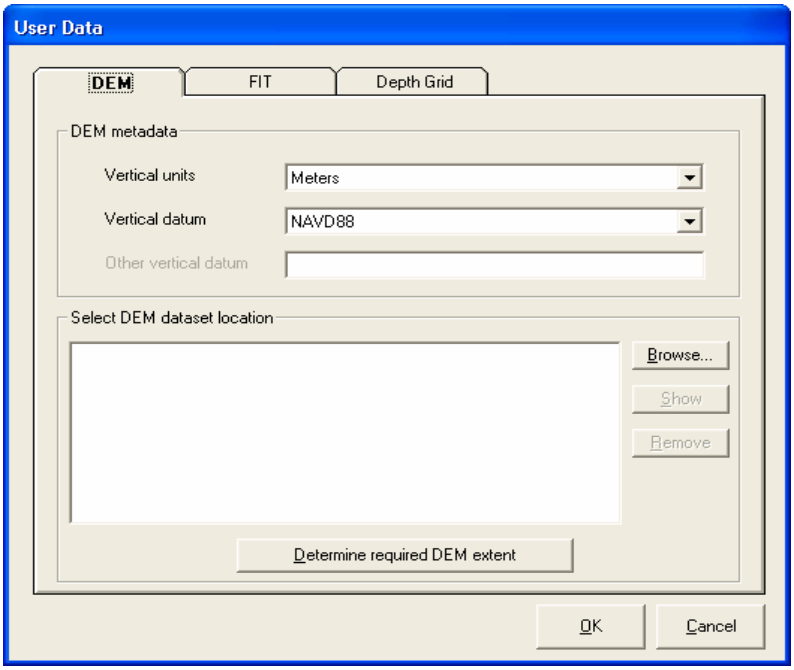


Figure 3.38 User Data Window

The window that pops up, shown in Figure 3.39, lists the latitude and longitude coordinates that you will need when downloading the USGS DEM data for your study region. The latitude and longitude shown may extend beyond the defined boundaries of your study region because the watersheds that affect the region's flood risk probably extend outside the political boundaries. This window includes simple instructions for downloading data from the USGS web site. More detailed instructions appear below.

Users of all Levels should note that any DEM provided to the Flood Model will need to meet the coordinate constraints established by this dialog. The Model will discontinue processing if the model identifies gaps in the data coverage. This does not preclude a user from using his or her own DEM.

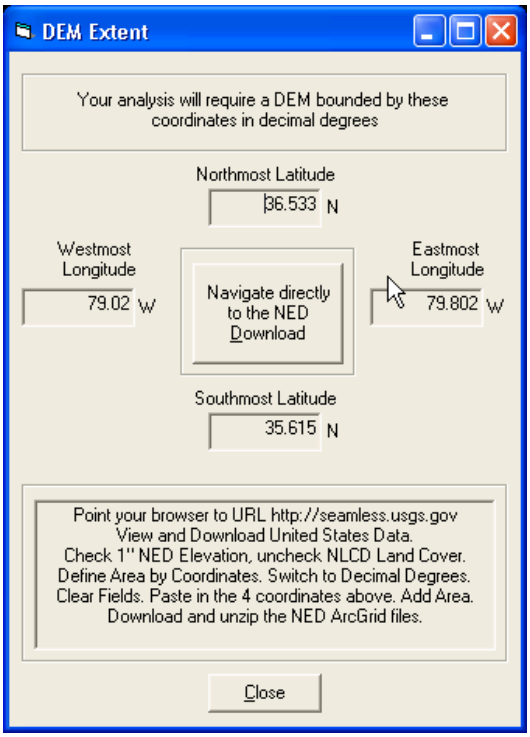

DEM Extent
Your analysis will require a DEM bounded by these coordinates in decimal degrees
Northmost Latitude
36.533 N
Westmost Longitude
79.02 W
Navigate directly to the NED Download
Eastmost Longitude
79.802 W
Southmost Latitude
35.615 N
Point your browser to URL http://seamless.usgs.gov
View and Download United States Data.
Check 1" NED Elevation, uncheck NLCD Land Cover.
Define Area by Coordinates. Switch to Decimal Degrees.
Clear Fields. Paste in the 4 coordinates above. Add Area.
Download and unzip the NED ArcGrid files.
Close

Figure 3.39 Coordinates for Required DEM

If pop-up blockers are enabled on your machine, it is important that they are disabled when you try to download the DEM.

The USGS makes minor modifications to their seamless website on a regular basis. Therefore the following dialogs may not be exact representations of what the user may find on the website. In general, however the basic functionality of the website has not changed and the following discussion should serve as an effective guide.

There are two ways to acquire the DEM from the NED website. The easiest is to click on the button "Navigate directly to the NED Download." This will access the NED site, enter the required coordinates, and direct the user to the download page.

However, it is possible that in the future the USGS will change the URL to their download site, which will necessitate users to go through the unabbreviated download process. To do so, proceed to the USGS web site http://seamless.usgs.gov/. Click on the button that reads *View and Order Data Sets – United States Viewer* on the welcome screen identified with the arrow in Figure 3.40 below. On the web page, shown in Figure 3.41, note that multiple boxes are checked under the heading *Download Layers* on the right-hand side of the page. Deselect all boxes except the *NED*. Then, click on the link on the left-hand side of the screen, towards the bottom of the page that reads *Define Area by Coordinates*. Note that you may have trouble viewing this link if your browser window is not large enough. The viewer is most easily seen if your screen resolution is 1024 x 768 pixels.

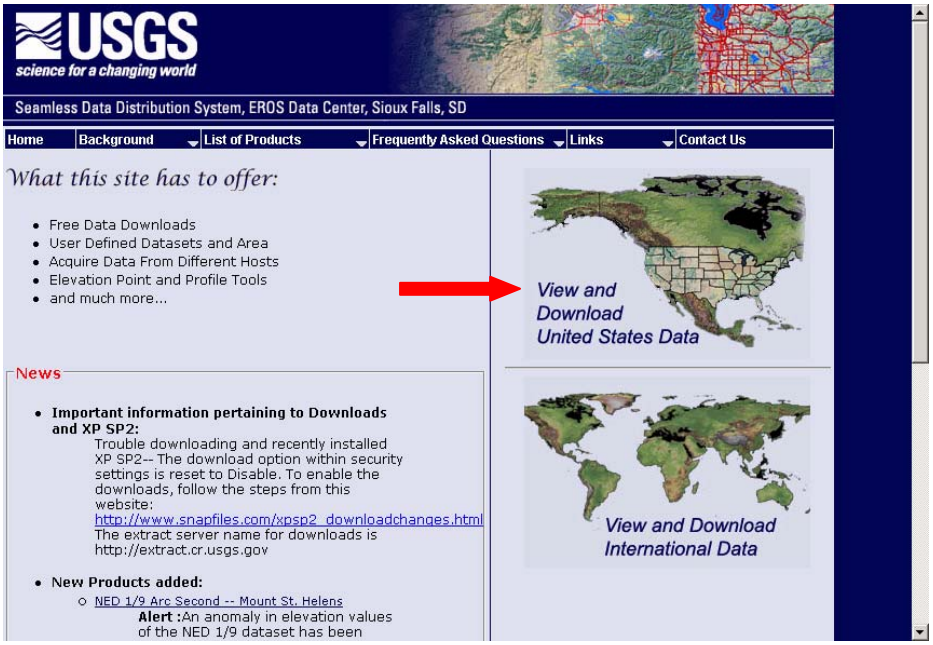

USGS
science for a changing world
Seamless Data Distribution System, EROS Data Center, Sioux Falls, SD
Home
Background
List of Products
Frequently Asked Questions
Links
Contact Us
What this site has to offer:
Free Data Downloads
User Defined Datasets and Area
Acquire Data From Different Hosts
Elevation Point and Profile Tools
and much more...
View and Download United States Data
News
Important information pertaining to Downloads and XP SP2:
Trouble downloading and recently installed XP SP2-- The download option within security settings is reset to Disable. To enable the downloads, follow the steps from this website:
http://www.snapfiles.com/xpsp2_downloadchanges.html
The extract server name for downloads is http://extract.cr.usgs.gov
New Products added:
NED 1/9 Arc Second -- Mount St. Helens
Alert :An anomaly in elevation values of the NED 1/9 dataset has been
View and Download International Data

Figure 3.40 USGS Seamless Welcome Screen

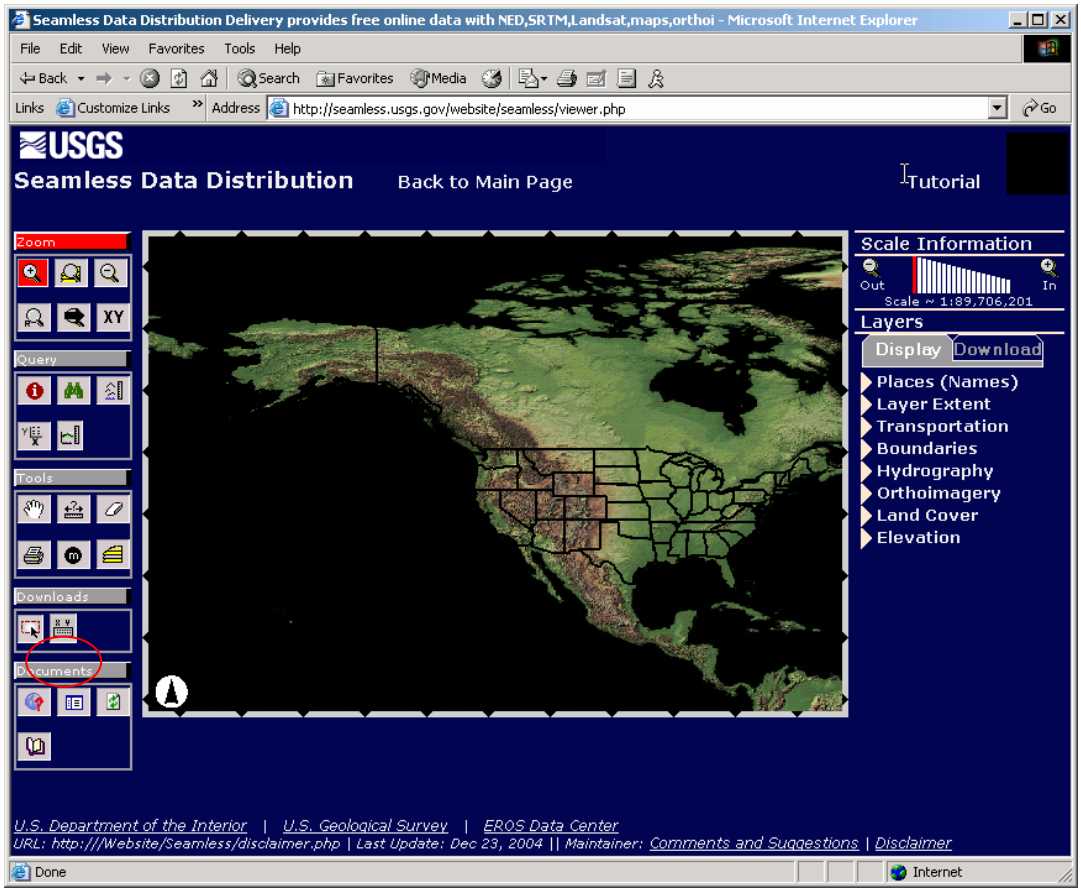


Figure 3.41 USGS Web Page for Seamless Data Distribution System

Be sure to check all other data layers off other than the NED. Failure to do so will typically lead to a message asking you to place an order for a CD-ROM of the data with an associated cost recovery fee. Rather large areas of NED data can be downloaded for free if the NED is the only layer requested.

The next web page you come to will prompt you to enter the latitude and longitude coordinates that define the limits of the DEM data you wish to download. Switch to entering coordinates in decimal degrees by clicking on the link. Then, copy the coordinates from your **HAZUS** study region *DEM Extent* window onto the USGS page, as shown in Figure 3.42. When you are done, press the **Add Area** button (circled). If incorrect numbers are entered or you would like to start over, click on **Clear Fields** to remove all data from the fields.

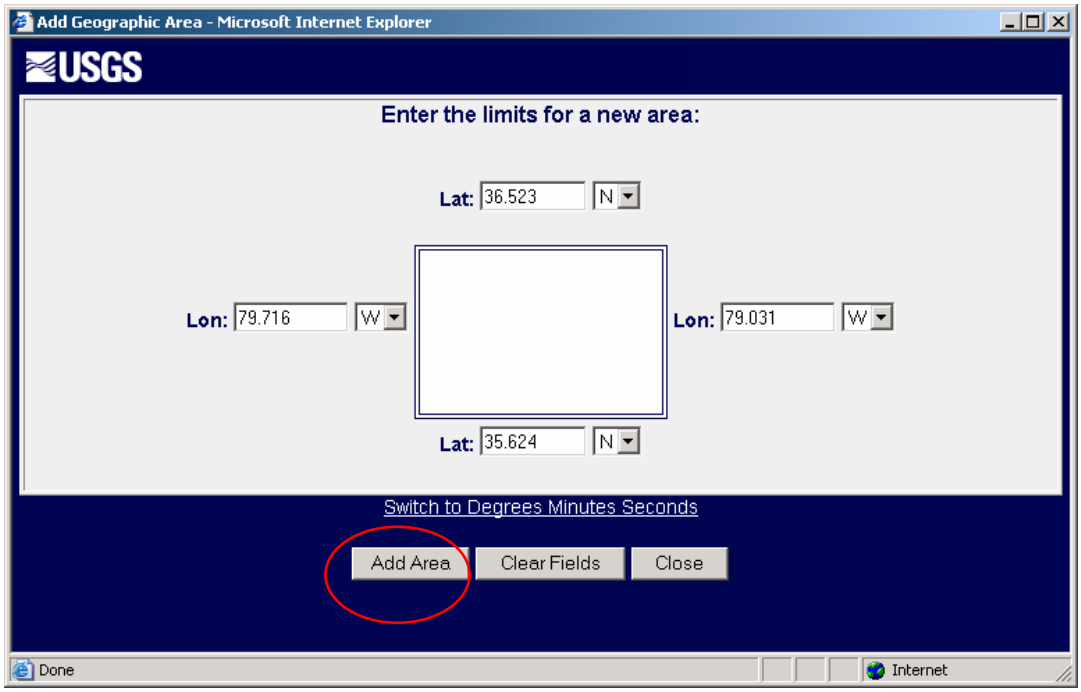


Figure 3.42 USGS Web Page Defining Geographic Area for DEM Data

The next page that will pop up will look similar to Figure 3.43. Click on the *Download* link and proceed to download the DEM data. The data will be stored in the form of a zip file, which you will need to unzip in any location you wish on your computer. Any WinZip compatible program should be able to unzip the data. For large areas, the user will be given the DEM in multiple zip files that they need to unzip and then select all one by one in the set DEM Data Paths dialog.

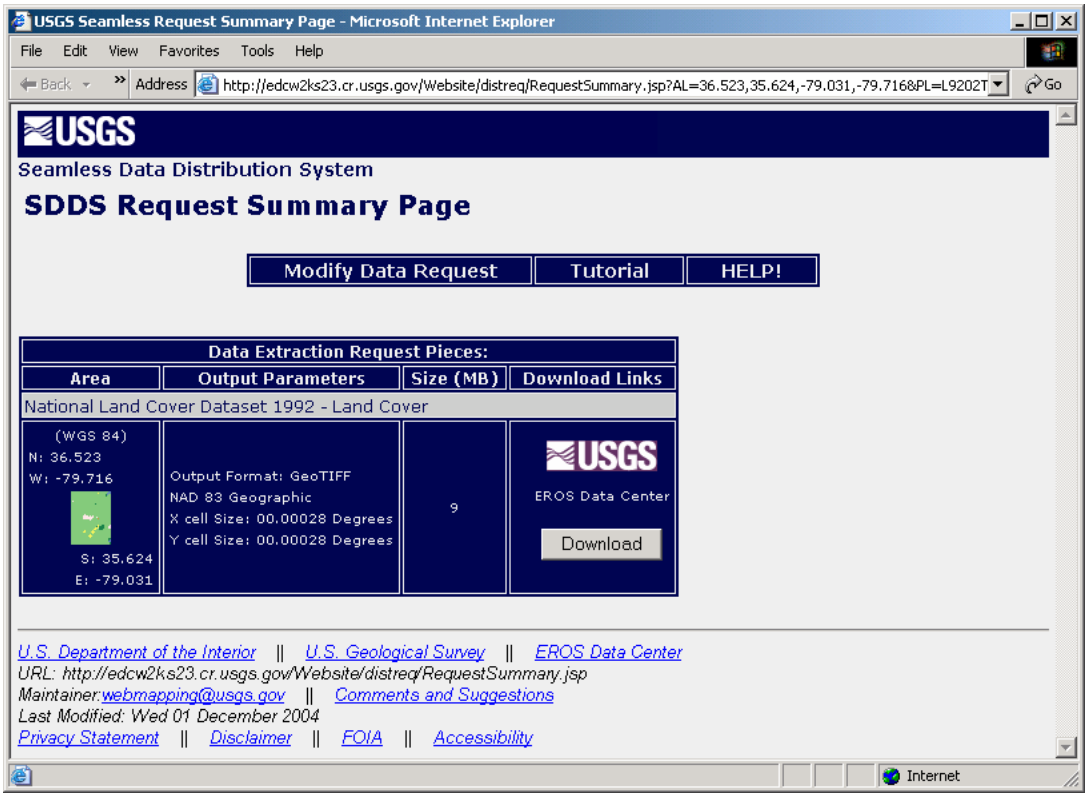


Figure 3.43 Download Page for USGS DEM Data

Users that have Windows XP Service Pack 2 (SP2) installed on their computer may run into problems with downloading the DEM from the USGS website. Windows XP SP2 comes with an automatic pop-up blocker that will deter the downloading process. The following screenshot is an example of what users might see. When the user clicks on the Information Bar, the user has the three options, shown below. Selection of the "Download File" option will not produce desired results, as seen in Figure 3.44.

USGS Raster Extraction Request Status - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://edcw2ks36.cr.usgs.gov/servlet/zipship.RequestStatus?zid=20050413.15593C
Go
To help protect your security, Internet Explorer blocked this site from downloading files to your computer. Click here for options...
Download File...
What's the Risk?
Information Bar Help
USGS The National Ma
Raster Extract has completed.
This window can be closed after saving the file.
U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center
URL: http://gisdata.usgs.net/Website/zipship/StatusRequest.jsp
Maintainer:webmapping@usgs.gov || Comments and Suggestions
Last Modified: Fri 28 June 2002
http://www.usgs.gov/
Internet

Figure 3.44 Security Settings Blocking Download

To avoid this problem, go to the "Tools" menu and click on "Internet Options", as shown in Figure 3.45.

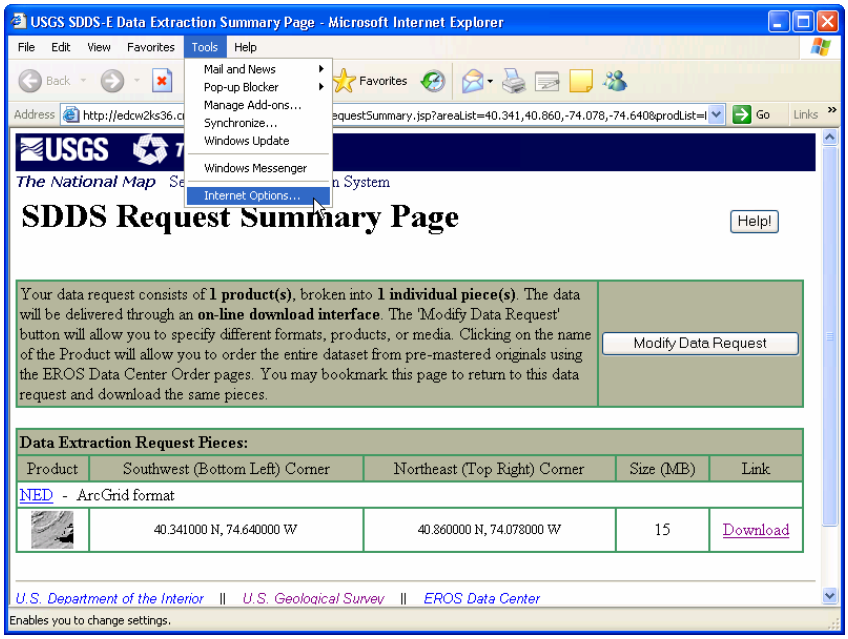

USGS SDDS-E Data Extraction Summary Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Mail and News
Pop-up Blocker
Manage Add-ons...
Synchronize...
Windows Update
Windows Messenger
Internet Options...
Favorites
Address
Go
Links
USGS
The National Map
SDDS Request Summary Page
Help!
Your data request consists of 1 product(s), broken into 1 individual piece(s). The data will be delivered through an on-line download interface. The 'Modify Data Request' button will allow you to specify different formats, products, or media. Clicking on the name of the Product will allow you to order the entire dataset from pre-mastered originals using the EROS Data Center Order pages. You may bookmark this page to return to this data request and download the same pieces.
Modify Data Request
Data Extraction Request Pieces:
Product
Southwest (Bottom Left) Corner
Northeast (Top Right) Corner
Size (MB)
Link
NED - ArcGrid format
40.341000 N, 74.640000 W
40.860000 N, 74.078000 W
15
Download
U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center
Enables you to change settings.

Figure 3.45 Set Internet Options for Download

Go to the "Security" tab, and click on "Custom Level" (circled in Figure 3.46).

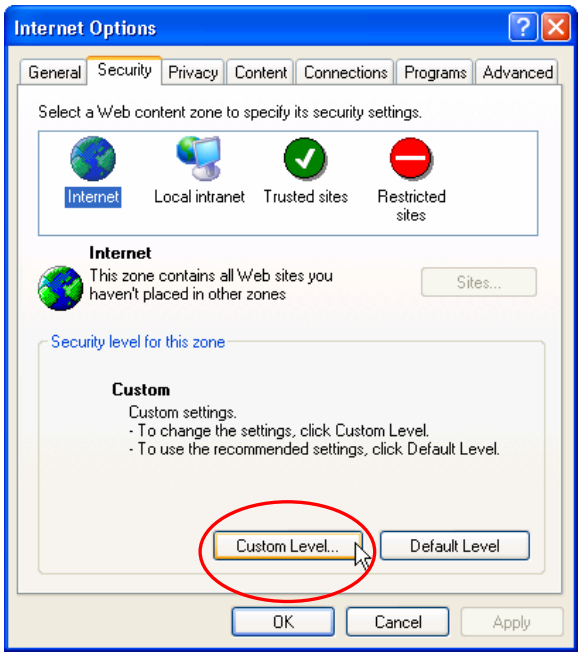


Figure 3.46 Internet Options

Scroll down to the Downloads section, and click "Enable" for all <u>two</u> options identified as "*Automatic prompting for file downloads*" and "*File download*" as shown in Figure 3.47 and click "OK"

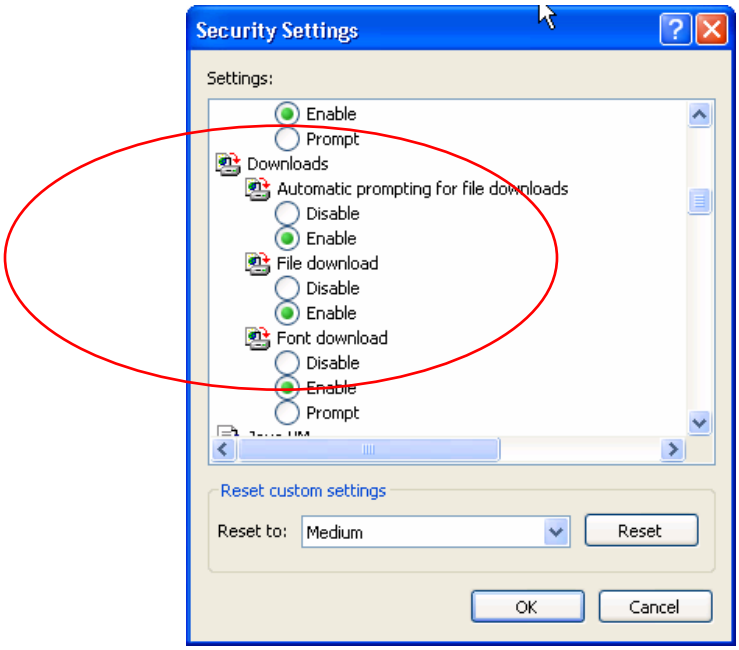


Figure 3.47 Security Settings for Download

Click "OK" to close the Internet Options window and restart the DEM download process.

3.3.4 Incorporate DEM Data

To incorporate the DEM data downloaded from USGS into the study region, you are prompted to enter three pieces of information in the DEM tab. First, enter the vertical datum used in the DEM file. Data downloaded from the USGS web site uses the NAVD88 vertical datum. Second, enter the vertical units of the DEM file, which should be Meters for USGS NED data. Third, click on the **Browse** button to locate the location of the unzipped DEM file on your computer. Click **OK**.

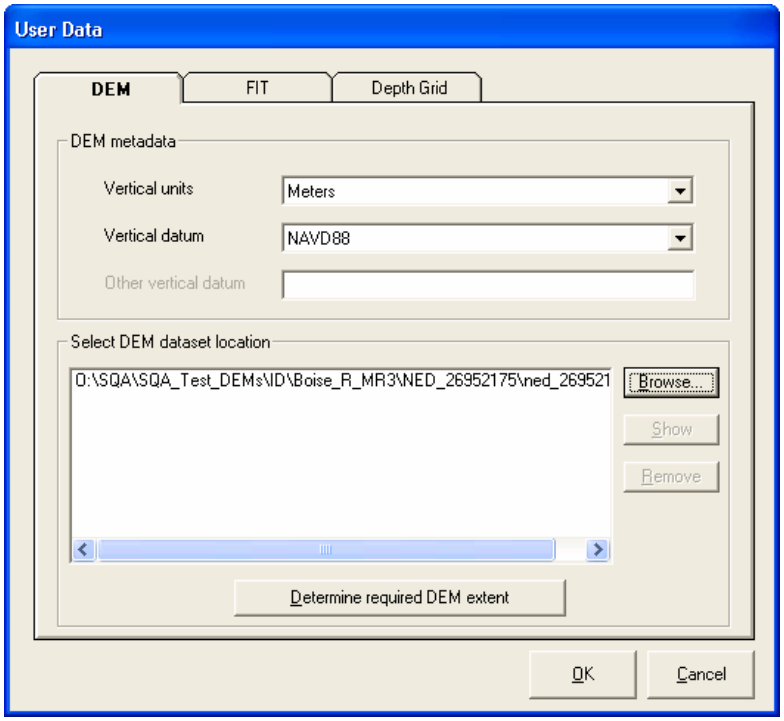


Figure 3.48 Setting DEM Data Paths

At this point, your computer will process the data in the DEM files, and select only those areas that are relevant to your study region. When this process is complete, a message box will notify the user that they can continue with the other hazard components. In some cases, the study region will require more than one DEM file from the USGS. If that is the case, the user should browse to each DEM individually to add them to the dialog seen in Figure 3.48 and the model will automatically merge the datasets for use in the Flood Model.

Note that Spatial Analyst extension must be active in ArcGIS for the DEM file to be properly integrated into the study region.

It has been observed that if the required DEM extent is large and USGS NED data is downloaded as multiple zip files, very rarely the USGS provided pieces will have a gap between them. This would have caused the stream network to be constructed incorrectly so HAZUS will validate the input DEM pieces and stop the process without going any further. The user will see the below message.

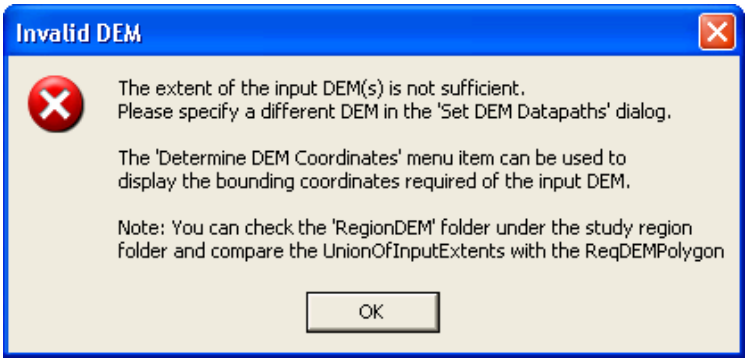

Invalid DEM
The extent of the input DEM(s) is not sufficient.
Please specify a different DEM in the 'Set DEM Datapaths' dialog.
The 'Determine DEM Coordinates' menu item can be used to display the bounding coordinates required of the input DEM.
Note: You can check the 'RegionDEM' folder under the study region folder and compare the UnionOfInputExtents with the ReqDEMPolygon
OK

Figure 3.49 Input DEM Validation Failed

The users who experience this issue can look at the UnionOfInputExtents and ReqDEMPolygon feature classes under the RegionDEM folder. The user should determine where the gap is occurring and causing the required DEM polygon not being completely contained within the union of input extents. The user then can note the coordinates, go to USGS NED website (http://seamless.usgs.gov/) and download the missing piece separately by following steps laid out in Download DEM Data from USGS section. Adding this additional piece through the DEM Data Paths dialog solves the problem. As seen in the example below (Clark County, NV), the UnionOfInputExtents have a gap that overlaps with the ReqDEMPolygon and additional piece of DEM is needed to cover that area. To better visualize the gap, the user can zoom in to area where it looks like the union polygon has a line cutting through it.

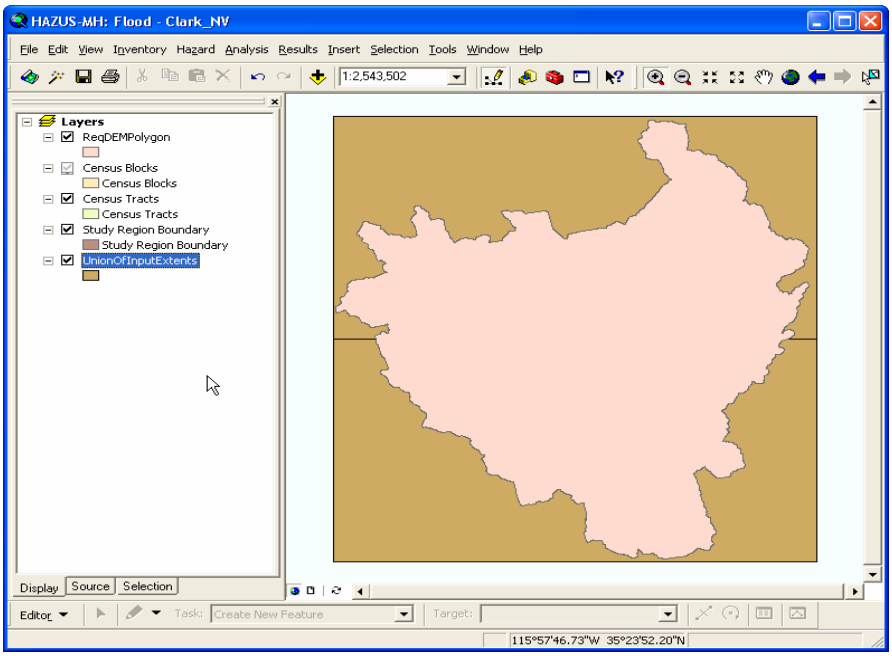


Figure 3.50 Example of Gap in USGS DEM

It has been observed that a portion of the DEM from the USGS NED site is missing, most commonly seen in study regions that are along the U.S. border. This would have caused the stream network to be constructed incorrectly so HAZUS will validate the input DEM pieces and stop the process without going any further. The users will see the message below.

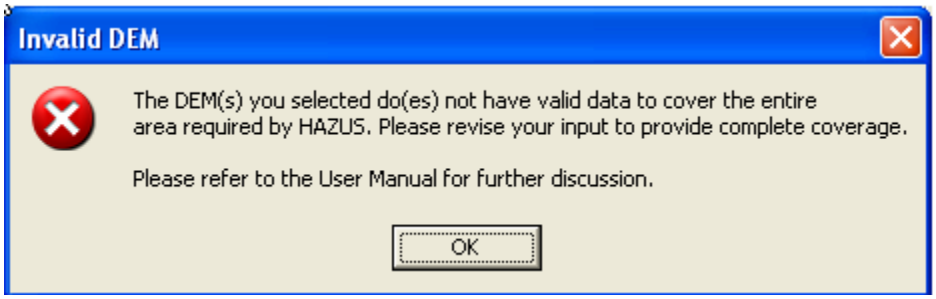

Invalid DEM
The DEM(s) you selected do(es) not have valid data to cover the entire area required by HAZUS. Please revise your input to provide complete coverage.
Please refer to the User Manual for further discussion.
OK

Figure 3.51 Input DEM Validation Failed

This issue is known to be triggered along the U.S. border, when the DEM source is from the USGS NED. Add the required DEM polygon and all input DEMs to the map to visualize the part that is missing. The current workaround is to obtain the 'missing' DEM(s) for the other side of the border.

3.3.5 Import Other User Data

A new feature in HAZUS is the ability for users to import flood depth grids, as well as FIT results. Users now have the option to bypass processing the DEM if they plan on running a scenario that only includes the FIT results and/or flood depth grids.

3.3.5.1 Import FIT Results

The flood information tool (FIT) is an ArcGIS extension separate from HAZUS that can be used to create flood hazard data for import to HAZUS. The data are prepared outside of HAZUS and model allows users to indicate the file location of FIT output. For more information regarding FIT, see section 4.2. Select *User Data* from the *Hazard* menu. In the User Data window, select the FIT tab and depending on the flood hazard type selected earlier, there will be a Riverine and/or Coastal tab available.

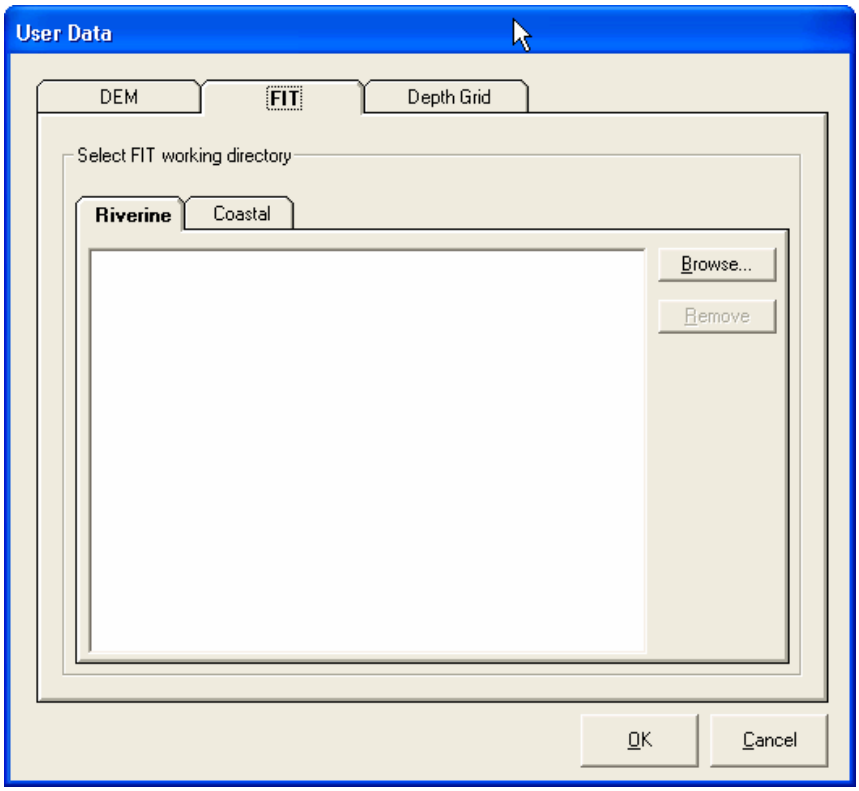


Figure 3.52 Importing FIT Data

Use the **Browse** button to browse to the location of the FIT working directory on disk. The browse dialog is intended to select a folder, not the contents of it, so be sure to click on the working directory (not double-click). It is important that users import the FIT working directory into the correct hazard tab. Repeat the process to import additional FIT working directories.

3.3.5.2 Import Flood Depth Grid Results

In order to import flood depth grid results into HAZUS, select *User Data* from the *Hazard* menu. In the User Data window, select the Depth Grid tab, as seen in Figure 3.53.

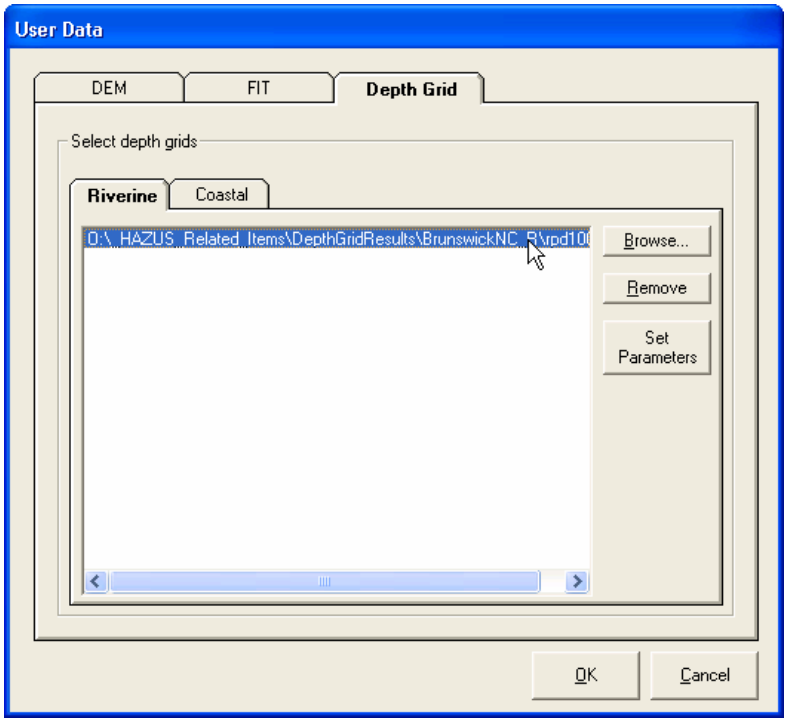


Figure 3.53 Importing Depth Grid Data

Use the **Browse** button to browse to the location of the flood depth grid on disk. The browse dialog is intended to select a raster. After the flood depth grid is selected, click on the newly imported flood depth grid and select the **Set Parameters** button. A window will pop up and ask the user to set the parameters to the flood depth grid. Select the **Units** (feet or meters) and input the **Return Period** of the flood depth grid, as seen in Figure 3.54. It is important that users import the flood depth grid into the correct hazard tab. Repeat the process to import additional flood depth grids.

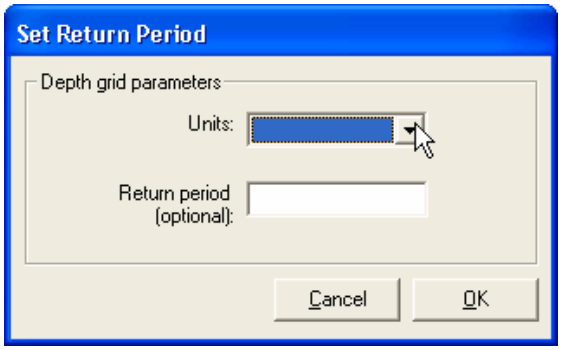


Figure 3.54 Set Parameters for Depth Grid

3.3.6 Riverine

At this point, the procedure for analyzing the hazard of the study region differs depending on whether your study region has riverine flood hazard, coastal flood hazard, or both.

3.3.6.1 Generate a Stream Network

If your study region is subject to riverine flood hazard, your next step is to generate a stream network. This is required even if you are going to be using FIT data. This is a one-time analysis and establishes the river network identity for all subsequent Scenarios. Select *Develop Stream Network* from the *Hazard* menu. The window shown in Figure 3.55 will appear. Enter an appropriate stream drainage area (in units of square miles), and click **OK**.

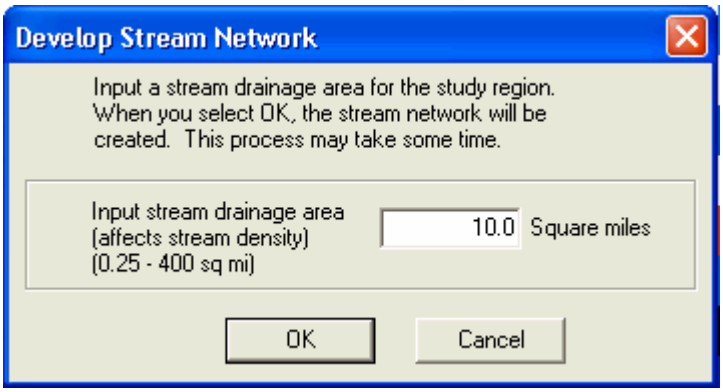

Develop Stream Network
Input a stream drainage area for the study region.
When you select OK, the stream network will be
created. This process may take some time.
Input stream drainage area
(affects stream density)
(0.25 - 400 sq mi)
10.0
Square miles
OK
Cancel

Figure 3.55 Selecting Input Stream Drainage Area

Your computer will process the DEM for your study region to determine the locations of streams. This analysis will take some time, ranging from five minutes to several hours, depending on your computer's processing speed, the size of the study region, and the complexity of the DEM. When the process is complete, the streams identified will appear on your study region, similar to Figure 3.56.

Selection a small number for the drainage area such as 1 square mile will result in a highly defined stream network. This value represents the total land area, in square miles, that drains into any given reach excluding that drainage at the starting node of the reach (the downstream node from the prior reach). The smaller the drainage area input by the user, the more processing time required by the flood model for subsequent analyses.

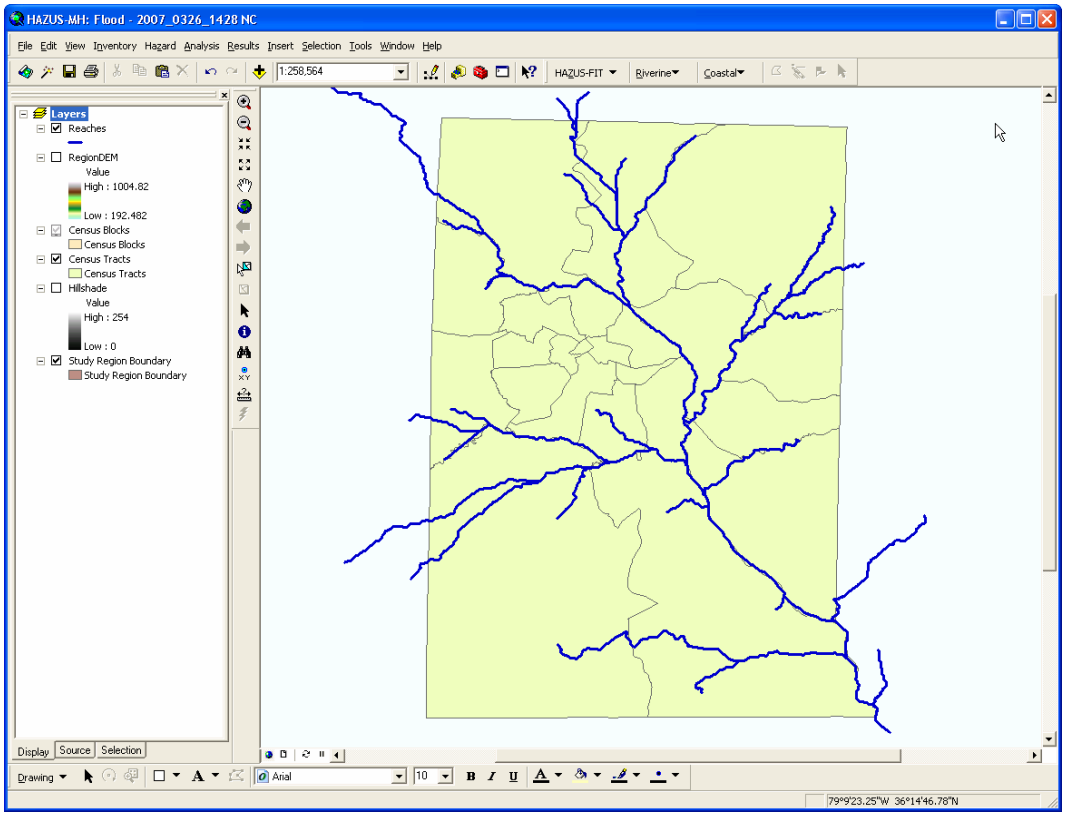


Figure 3.56 Stream Network

Running the stream network the first time is fairly time consuming because the model performs an analysis that fills in spurious sinks in the DEM. However, in order to save the user time, the model saves the results of the sink filling process so that if the user decides to change the drainage area number, the model will not need nearly as much time to perform the analysis. For example, if the user runs stream network at 5 square miles and then decides that the network is not fine enough, the change to 1.0 square miles will run significantly quicker than the original analysis.

If a river to be analyzed forms a border between counties, it is suggested to include the counties on both sides of the river when creating the study region. The stream network in HAZUS is known as a synthetic network because it is derived entirely from the DEM. No imagery or pre-existing map layers are used in its generation. More specifically, streams in a synthetic network exist wherever at DEM grid cell locations that receive drainage from a threshold number of upstream grid cells. If the DEM is not large enough, the threshold number of grid cells may not be reached. An example of this is shown in Figure 3.57. It shows a study region consisting of one county, for which the one river (in red) forms a border. But because the DEM does not include areas draining to both sides of the river, the resulting synthetic stream is discontinuous. There are simply not enough DEM grid cells draining to the discontinuous portions for them to properly delineate.

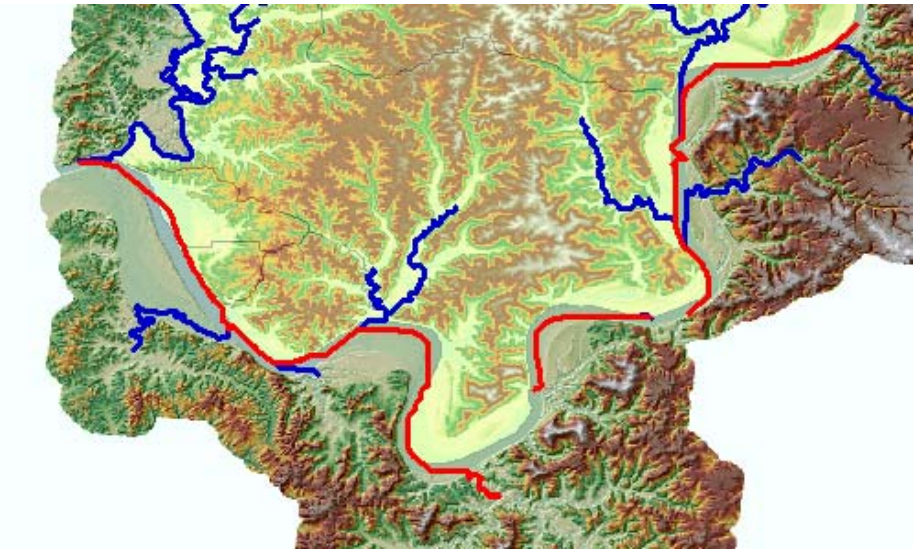


Figure 3.57 Discontinuous Synthetic Stream

The solution to this discontinuity is to include counties on both sides of the river during study region creation. This in turn will result in a larger DEM that drains to both sides of the river. Figure 3.58 illustrates this concept, using the same stream as shown in Figure 3.57. The second study region consisting of counties on either side of the river (shown in red). The resulting synthetic stream network is now continuous.

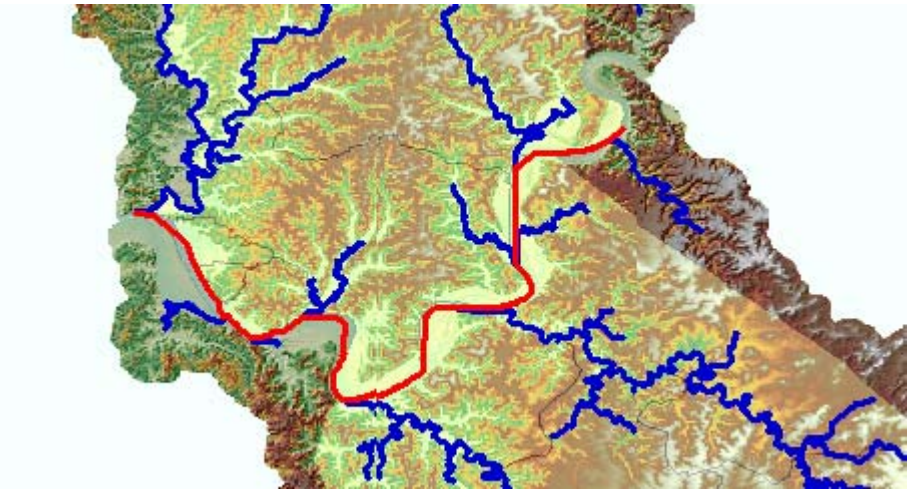


Figure 3.58 Continuous Synthetic Stream

3.3.6.2 Defining a Scenario

Next, select *Scenario* under the *Hazard* menu, and select *New*. A scenario defines the specific stream reaches, or lengths of coastline for coastal users, and the hydrologic and hydraulic characteristics that you wish to include in one analysis run. A scenario could include all stream reaches in your study region, but because the analysis requires significant computer processing, you may wish to divide the region into several smaller scenarios.

You will be prompted with a window to name your scenario and, optionally, write a description. Be careful not to include any leading or trailing spaces in the scenario name. When opening scenarios in the future, your description will be visible to help you differentiate between similar scenarios. Figure 3.59 shows an example of the scenario-naming dialog.

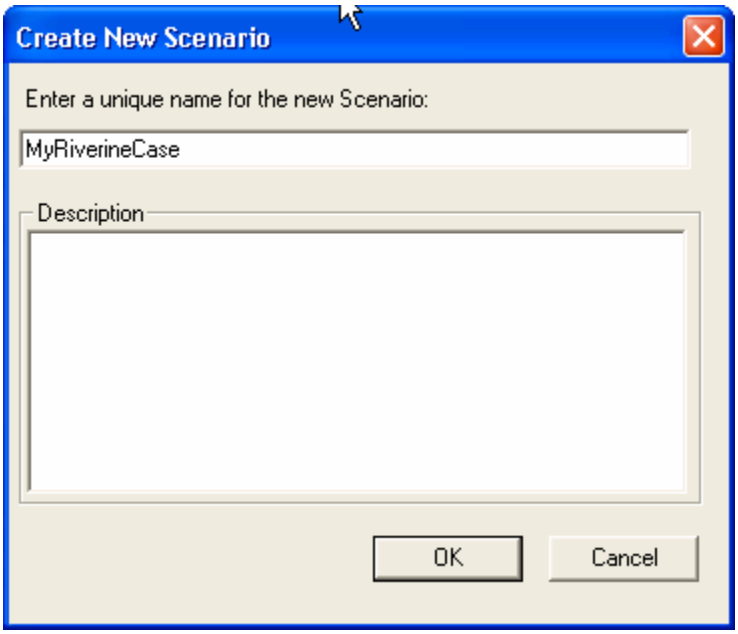


Figure 3.59 New Scenario Naming

After naming the scenario, a window will open enabling you to select which stream reaches you would like to include in the scenario, shown in Figure 3.60. You may use the "Select Elements" tool (the button with the arrow icon) to select particular stream reaches by clicking on them, or to drag a box and select multiple stream reaches. If you hold down the shift key, you can add or remove additional stream reaches to your selection by clicking on them. Once you have selected the stream reaches you want to include, which will be highlighted, click on *Save*.

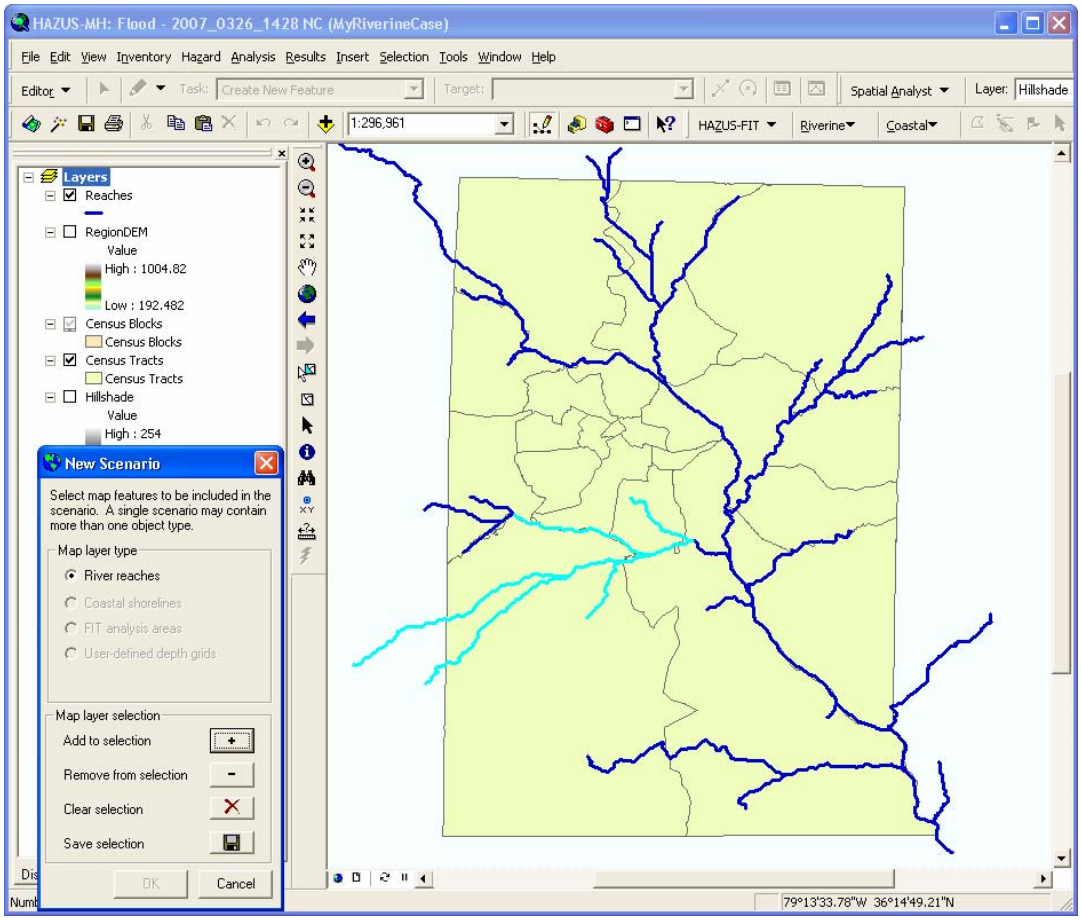


Figure 3.60 Selecting River Reaches for a Scenario

If you have imported any riverine FIT data and/or flood depth grid(s), you can select those areas by clicking on the FIT analysis areas and/or the User-defined depth grids radio buttons. Select and save FIT areas and/or flood depth grids in the same manner as reach selection. After you save the stream reaches you have selected, you can press *OK* to complete the definition of the scenario. The color of the highlighting of the selected streams will change when this process is complete.

The Scenario "Save As" capability was created to allow users to skip the hazard analysis every time they wanted to run different parameters in the Inventory or Analysis menu. It is designed to save time for the user so that they can skip the hazard portion and rerun Analysis. It also gives the user a way to preserve previous results without using the Duplicate Study Region function, which requires much more disk space. The results tables are Scenario specific and the creation of a new scenario through the "Save As" function assumes the user wants new results. Therefore, the old results are not carried over.

In order to use the "Save As" capability, the scenario to be saved needs to be open. The user then selects "Save As" from the Scenario selections under the Hazard menu, as seen in Figure 3.61.

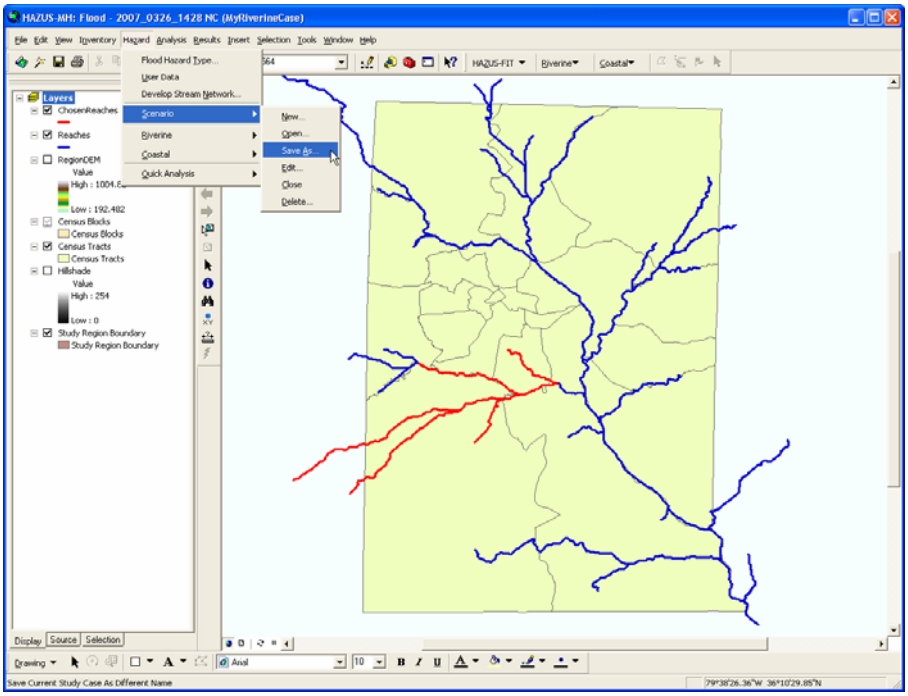


Figure 3.61 Scenario "Save As" Menu

You will be prompted with a window to name your new scenario and, optionally, write a description. Figure 3.62 shows an example of the Scenario Save As naming dialog.

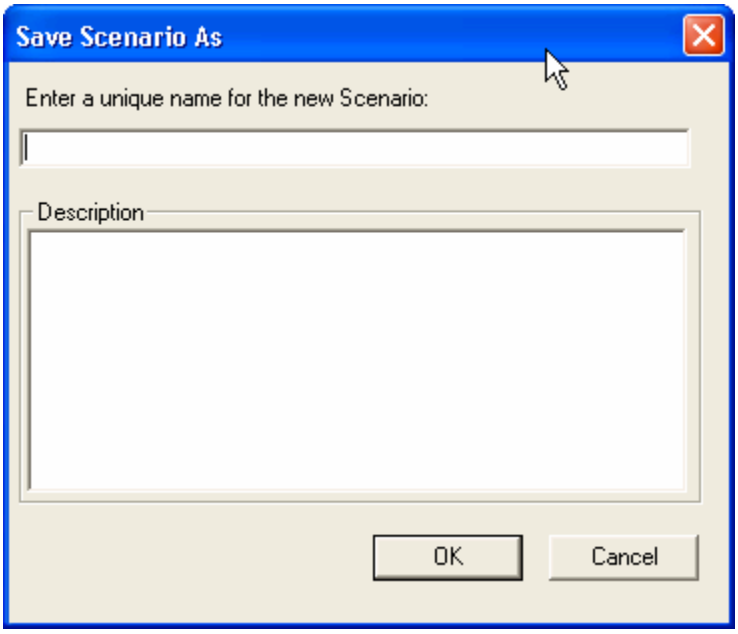


Figure 3.62 Scenario "Save As" Naming

After clicking OK, HAZUS will save the old scenario and automatically open the new scenario.

When a user modifies the Inventory, he/she is affecting all future results, meaning that any analysis from that point on will use the updated inventory. It is recommended that if the Inventory is modified, the Analysis should be rerun. Users that plan on modifying the inventory should "duplicate" the Study Region to compare results, otherwise the results are overwritten. The results will be overwritten if and only if the user reruns Analysis on the same scenario.

Users that plan on modifying the functions/parameters in the Damage & Loss Estimate Analysis should use the Save As capability to compare results between scenarios, otherwise they are overwritten. The changes to damage functions are per Study Region, so the user is responsible for knowing what damage functions were used to create the results of which scenario. The user will not have a way of displaying which damage functions were used for each scenario.

Users that plan on modifying the Hazard analysis do not need to use the Save As capability. However, there are a few cases that need to be taken into consideration.

- Mix grid: Mix grids are created when HAZUS does not know what return period to assign to the grid, such as the case of running specific discharge analysis or assigning different return periods to different reaches in a single scenario. If a user is dealing with a mix case and reruns the Hazard by changing some parameters (return period of one or more reaches, or the discharges), the changes to the depth grid and floodplain polygon due to this rerun will not be reflected in the Analysis results until the Analysis is reran.
- Edits to scenario: If a user reruns the Hazard by adding or subtracting at least one reach from the scenario but uses the same return period, the user should rerun the Analysis so that the results would reflect the changes in the Hazard.
- FIT: FIT results can only be modified in FIT. Inside the Flood model, the only option available to the user in terms of modifying FIT results is the ability to choose which FIT Areas to include in the scenario. If that kind of modification is done to the Hazard, the user should rerun the Analysis so that the results reflect the changes in the Hazard.

In all three cases, if the user reruns the Analysis without using the Save As capability, the previous results will be lost.

The Scenario "Delete" capability was designed to allow users to delete scenarios that are no longer needed. The "Delete" function allows users to delete multiple scenarios all at once by simply clicking on the scenarios.

In order to use the "Delete" capability, the scenario to be saved needs to be open. The user then selects "Delete" from the Scenario selections under the Hazard menu, as seen in Figure 3.63.

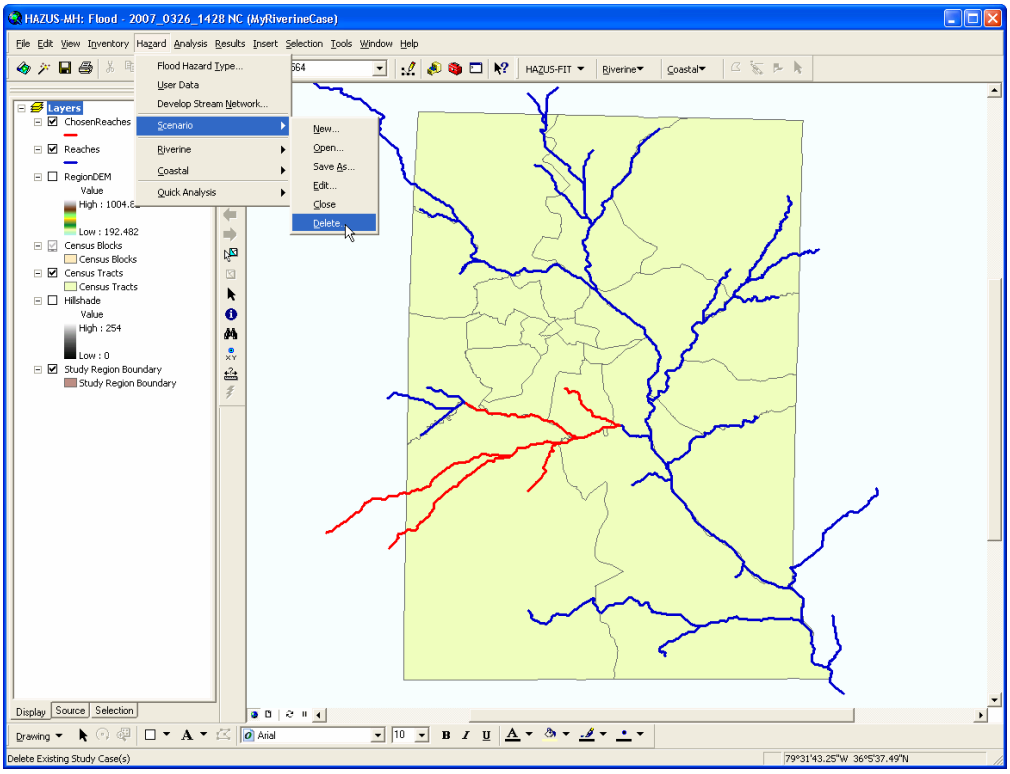


Figure 3.63 Scenario "Delete" Menu

You will be prompted with a window that shows all scenarios that have been created for the study region. Figure 3.64 shows an example of the Delete Scenario dialog.

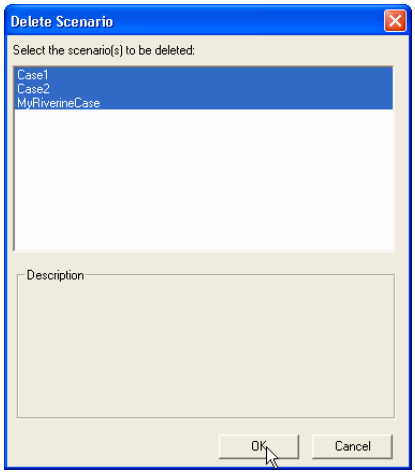


Figure 3.64 Delete Scenario

Select scenario(s) to be deleted by clicking on the scenario name and click OK.

3.3.6.3 Hydrologic Analysis

Once you've defined your scenario, the *Hydrology* option from the *Riverine* submenu becomes enabled. Selecting this submenu option will launch the hydrologic calculations for the scenario stream reaches that you have selected. These calculations will take some time, which will vary by the number and characteristics of the stream reaches selected and computer processing speed. The flood model has a status bar that allows the user to track the percentage of completion of the analysis. **HAZUS** will notify you when the calculation is complete.

There is a tendency for ArcMap and HAZUS to experience memory leaks that can lead to failure of the model to complete its analysis. Since the hydrology analysis is study region specific and is dependent only on the river network developed by the user, there are options available to reduce the possibility of the code reaching a memory limit.

In the case of hydrology, it is recommended that the user perform the hydrology analysis on a watershed-by-watershed basis, thereby limiting the level of effort within the model. There are two recommended approaches:

- Create a scenario for each watershed and perform the hydrology analysis on each scenario. The hydrology results are stored in a single table independent of scenario, or

- Create a single scenario, start with one watershed and perform the hydrology analysis. When completed, edit the scenario, add the next watershed and rerun the hydrology analysis. The model will skip those reaches that already have had the hydrology analysis performed and will perform the analysis on the added reaches. Repeat as needed to complete all watersheds in the study region.

Hydrologic analysis is only important if you wish to perform frequency-related flood analyses (i.e., 100-year return period, annualized loss, etc.). If you have a specific discharge to apply to your reach(es), proceed directly to the Delineate Floodplain (Riverine) menu item and select Single Discharge.

When running hydrologic analysis, the HAZUS screen might go blank or the Task Manager "Applications" tab will indicate that HAZUS is not responding. This is a common symptom for any software that is process heavy. In order to check if HAZUS is still running, users should check the Task Manager "Processes" tab and sort the "CPU" column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99-100%, this is a clear indication that HAZUS is not responding. Users could also check the "Performances" tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the study region folder (in "Details" view) and make sure the FlHydrologyLog is updating by looking at the "Date modified."

3.3.6.3.1 Excluding Problem Reaches from Scenario

The following are instructions for creating a Scenario that excludes problem reaches. This only applies to cases where the Hydrology process shows the message in Figure 3.65.

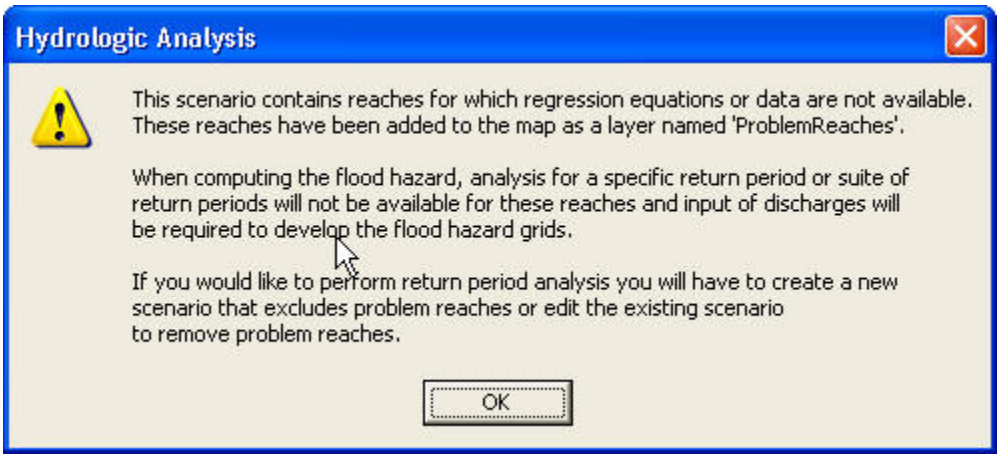

Hydrologic Analysis
This scenario contains reaches for which regression equations or data are not available. These reaches have been added to the map as a layer named 'ProblemReaches'.
When computing the flood hazard, analysis for a specific return period or suite of return periods will not be available for these reaches and input of discharges will be required to develop the flood hazard grids.
If you would like to perform return period analysis you will have to create a new scenario that excludes problem reaches or edit the existing scenario to remove problem reaches.
OK

Figure 3.65 Hydrology Process Fail due to Problem Reaches

1. Start HAZUS, open your Study Region and open your Scenario
2. Make sure the "ProblemReaches" and "ChosenReaches" are on the map, if yes, skip to step 4
3. If not, add it through "Add Data" button, browse to \\Study Region Folder\Scenario Folder\Riverine\CaseOutput\Hyrdology\
4. Make sure the "Reaches" is on the map, if yes, skip to step 6
5. If not, add it through "Add Data" button, browse to \\Study Region Folder\Riverine\FlAnRivOutput\Region\
6. From the Main Menu bar, go to "Selection" and click on "Select by Location"
7. Make sure the first dropdown menu shows "Select features from"
8. Check "ChosenReaches" in the "the following layer(s)" window and uncheck all others
9. Select "are identical to" as the relationship in the dropdown menu of "that"
10. Select "ProblemReaches" in the "the features in this layer" dropdown
11. Make sure "Use selected features" and "Apply a buffer" are unchecked
12. Hit "Apply"
13. Confirm that the number of selected reaches on the ChosenReaches layer is the same as the number of total reaches in "ProblemReaches"
14. Right click on ChosenReaches in the "Table of Contents" and click on the "Open Attibute Table"
15. Click on "Options" and then "Switch Selection", note the number of selected features
16. Close the attribute table
17. From the Main Menu bar, go to "Selection" and click on "Select by Location"
18. Make sure the first dropdown menu shows "select features from"
19. Check "Reaches" in the "the following layer(s)" window and uncheck all others
20. Select "are identical to" as the relationship in the dropdown menu of "that"
21. Select "ChosenReaches" in the "the features in this layer" dropdown
22. Make sure the "Use selected features" IS checked and "Apply a buffer" is unchecked

23. Hit “Apply”
24. Right click on Reaches in the “Table of Contents”, click on the “Open Attribute Table” and confirm that the number of selected reaches is the same as the number noted in step 14
25. Close the attribute table
26. From the Main Menu bar, go to “Hazard, “Scenario”, “New”
27. On the “New Scenario” dialog, hit “Save selected objects”, then click “OK”
28. The Scenario is now ready to start Hydraulics (Riverine\Delineate Floodplain) for a scenario that excludes the ProblemReaches from the ChosenReaches of the original Scenario (**The Hydrology does not need to be rerun since HAZUS has already computed discharges for non- ProblemReaches. If Hydrology is rerun, the results will remain the same since the ProblemReaches have been removed from the Scenario**)

3.3.6.4 Delineate Floodplain - Riverine Hazard

Once the hydrologic calculations are completed, the *Delineate Floodplain* submenu option on the *Riverine* submenu on the *Hazard* menu becomes enabled. Select this submenu option, and the window shown in Figure 3.66 will appear. From the pull-down menu, you can select the type of hazard analysis you would like to run. At the bottom of the window, HAZUS will indicate how much virtual memory is available on the machine and the estimated virtual memory that will be used for the hydraulic analysis. If the text is in red, as seen in Figure 3.66, the hydraulics process will need more memory than what is available. If this occurs, it is recommended that users remove reaches from the scenario.

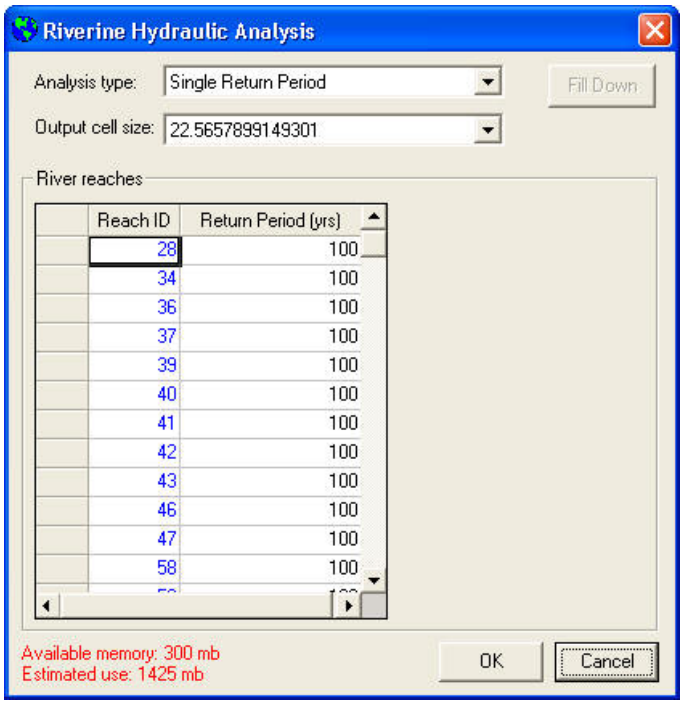


Figure 3.66 Calculate Hazard Window

1. Selecting *Return Periods 10, 50, 100, 200, 500* will calculate flood depths and floodplains for the 10-year, 50-year, 100-year, 200-year and 500-year return period floods on each of the stream reaches in your scenario. The flood model will produce a single 10-year flood depth grid for the entire group of selected reaches. This process is duplicated for the other four return intervals.

2. Selecting *Single Return Period* lets you specify a return period between 10 years and 500 years for which the flood characteristics will be calculated. You can choose different return periods for different stream reaches, if you wish. Depending on the user selection, the resultant grid will be a single return interval for all reaches selected by the user, similar to option 1 above, or a single grid of mixed return intervals for the selected reaches.

3. Selecting *Single Discharge* allows you to input anticipated stream discharge levels for each stream reach. Similar to *Single Return Period*, the user can enter different discharges for each reach.

If the user opts to run different return intervals or specific discharges for each reach in their scenario, the Transportation Bridge analysis cannot be run as the return interval for the reaches in question needs to be known.

4. Selecting *Annualized Loss* will calculate a suite of floods to be used later in an annualized loss calculation. The annualized loss menu item on the *Analysis* menu will become enabled when this has been completed.

This completes the hazard definition for the riverine analysis. When performing a mixed case analysis (riverine and coastal), the user will need to perform the steps outlined in this section for the riverine portion of their analysis. The next section will define how to operate the flood model for the coastal analysis. Please feel free to skip this section and read about the *Analysis* and *Results* functionality.

When running hydraulic analysis, the HAZUS screen might go blank or the Task Manager "Applications" tab will indicate that HAZUS is not responding. This is a common symptom for any software that is process heavy. In order to check if HAZUS is still running, users should check the Task Manager "Processes" tab and sort the "CPU" column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99-100%, this is a clear indication that HAZUS is not responding. Users could also check the "Performances" tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the scenario folder (in "Details" view) and make sure the FlHydraulicsLog is updating by looking at the "Date modified."

Cell sizes are obtained from the DEM, FIT, and/or user-defined depth grids, depending on what is being used in the scenario. From the pull-down menu, you can select which cell size will be used for the final depth grid (if more than one is available).

Using a smaller cell size could dramatically increase the processing time and the size of the output raster. Also, using a smaller cell size in areas that had a larger cell size ***does not*** increase the accuracy of the depth grid, it will just preserve the high accuracy in the areas that had small cell sizes. On the flip side, using a larger cell size will result in a faster processing time, but will cause the user to lose the higher accuracy in the areas that had small cell sizes.

3.3.6.4.1 Reaches with Hydraulic Problems

As the user is running the hydraulics (i.e. Compute Flood Hazard), the user might notice that it is taking a long time. It is possible that the hydraulic process is hanging (stuck on a couple of reaches and cannot finish hydraulics). The following are instructions to go around the problem.

1. Open FlHydraulicsLog.txt and search for the text "Reach # of" (# being the reach process hangs at)
2. The line above that will have "CoreOfHydraulics: Processing REACH ID: XX", note the reach ID
3. Start HAZUS, open your Study Region and open your Scenario
4. Make sure the "Reaches" layer is on the map, if yes, skip to step 6
5. If not, add it through "Add Data" button, browse to \\Study Region Folder\Riverine\FlAnRivOutput\Region\
6. From the Main Menu Bar, go to "Selection" and click on "Select by Location"
7. Make sure the first dropdown menu shows "select features from"
8. Check "Reaches" in the "the following layer(s)" window and uncheck all others
9. Select "are identical to" as the relationship in the dropdown menu of "that:"
10. Select "ChosenReaches" in the "the features in this layer" dropdown
11. Make sure "Use selected features" and "Apply a buffer" are unchecked
12. Hit "Apply"
13. Confirm that the number of selected reaches on the "Reaches" layer is the same as the number of total reaches in "ChosenReaches"
14. Right click on “Reaches” in the "Table of Contents" and click on the "Open Attribute Table"
15. Look for the row that has its "ARCID" value equal to the reach ID you noted at step 2, this is the problematic reach. It should already be highlighted as one of the selected reaches.
16. Select Ctrl and left-click on the left end of that specific row (the gray block part on the table, not the cells inside the table) to deselect it.
17. Close the attribute table
18. From the Main Menu Bar, go to "Hazard", "Scenario", "New"
19. On the "New Scenario" dialog, hit "Save selected objects", then click "OK"
20. The Scenario in now ready to start Hydraulics (Compute Flood Hazard\Riverine Hazard) for a scenario that excludes that specific Problematic reach from the ChosenReaches of the original Scenario

3.3.7 Coastal

If the flood hazard of concern is coastal, you will not be required to generate a stream network or run the hydrologic analysis. You will still be required to obtain and identify the Digital Elevation Model to be used in the analysis. The extent of the DEM necessary for coastal is different from that required for riverine. The necessary DEM is determined by the union of the region shoreline with the study region boundary.

Once the DEM has been added (see Section 3.3.3 and Section 3.3.4) the user can move directly to defining a scenario by selecting *New* from the *Scenario* submenu and the *Hazard* menu. As with the riverine analysis, the user is required to enter a name and, if desired, a description for the scenario, and click **OK** as seen in Figure 3.67 below.

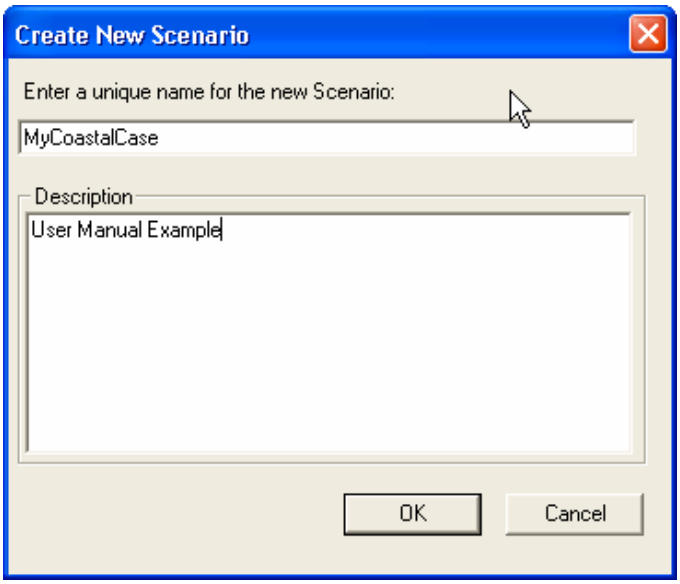


Figure 3.67 New Scenario (Coastal)

After the user has specified the scenario name and clicked on **OK**, the window shown in Figure 3.68 will emerge. Like the riverine model, the user will be asked to select a shoreline or shorelines for analysis. The flood model uses a standard GIS selection tool to allow the user to select the shorelines and the user should click on the select icon and proceed to either click on the shoreline or draw a box to select more than one shoreline.

To select discontinuous shorelines such as islands, the user can press the Shift key while selecting additional shorelines. To deselect shorelines, the user can press the Shift key and click on the shorelines that are not to be included in the selected shorelines.

HAZUS has a built-in default national shoreline that is delineated by county. In study regions that are sub-county or a combination of multiple sub-counties, all of the associated shorelines of the counties will be brought in. This is by design and it is to account for the fact that coastal flooding at a specific location does not necessarily originate from the closest shoreline to that location.

The flood model has shorelines for mainland areas, barrier islands, large islands, small islands and the Great Lakes. These shorelines have been smoothed to allow the flood model to build shore normal transects in a less time consuming fashion.

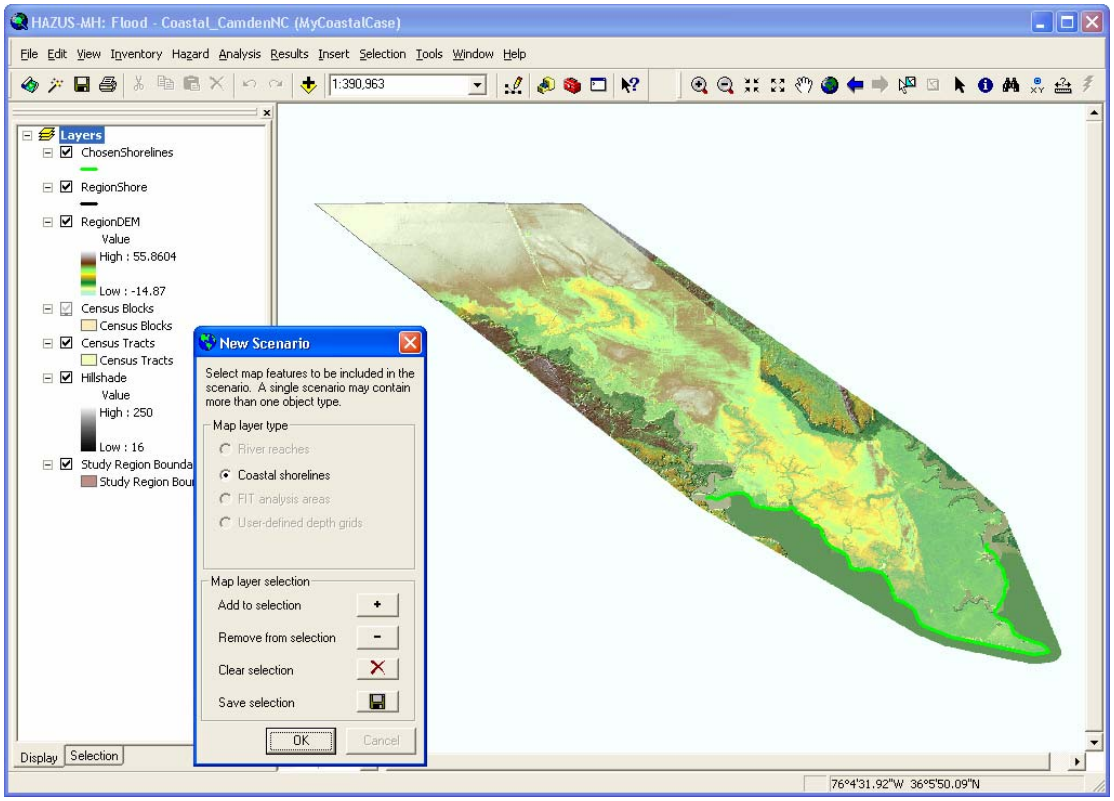


Figure 3.68 Selecting a Shoreline for a New Coastal Scenario

Once the shorelines have been selected, click on the **Save Selected Objects** button (the floppy disk icon) and the **OK** button will become enabled. This completes the process of creating the new scenario and selecting shorelines. The next step in the process is to characterize the chosen shorelines.

3.3.7.1 Shoreline Characterization

Characterizing the shorelines provides the flood model with the information necessary to determine which models will be run, including frontal dune erosion, WHAFIS, and Runup. The flood model provides the opportunity for the user to characterize the shoreline into six (6) major shoreline types. The shoreline types include: Rocky Bluffs, Sandy Bluffs with Little Beach, Sandy Beach with Small Dunes, Sandy Beach with Large Dunes, Open Wetlands, and Erosion Protection. The selection of one of these six shoreline types helps guide the flood model as to which hazard analysis must be performed.

To characterize the shoreline, the Shoreline Characterization window will automatically pop up after shoreline(s) are selected for the scenario. Selection of this menu item starts a process where the user identifies where they would like to start characterizing the shoreline (Shoreline Start) and where they would like to finish the characterization (Shoreline Finish). In between these two points, the user will want to add any breaks in the shoreline (Breaklines) where the geographic characteristics of the shoreline change. The flood model will develop transects and perform the aforementioned analysis (e.g., WHAFIS) only between the Start and End lines. If the default locations are moved, the model will limit the development of transects between these locations.

The flood model will develop transects and perform analyses such as WHAFIS between the Start and End lines – either the default or those generated by the user. The flood model will still develop a Stillwater elevation surface over the entire study region to insure that flooding through other low-lying areas is properly accounted for.

The first dialog allows the user to perform the segmentation of their shoreline if necessary. Figure 3.69 shows the dialog, which is interactive with the map layer as shown.

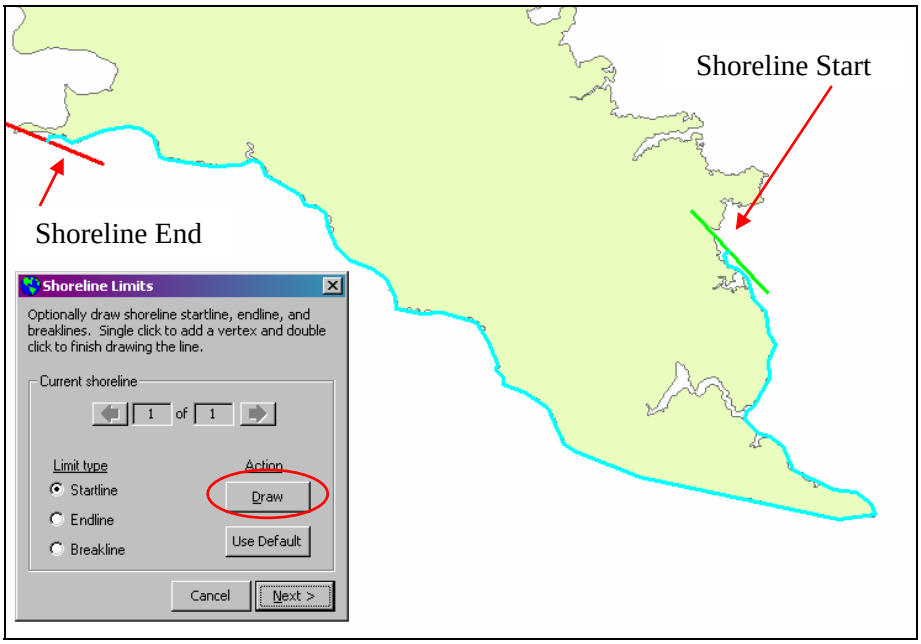


Figure 3.69 Setting Shoreline Limits

The user can leave the shoreline start and end as seen in the dialog above or select the limit to be changed (Startline or Endline) and click the Draw button (circled) to draw a new line on the map. The model will remove the default line and replace it with a line in the location of the users choosing. For example, Figure 3.70 shows what the user might see upon changing the shoreline start point (Startline).

The user must be sure to draw the line so that it crosses the shoreline only once. This could be from inland into the flood source, or from the flood source inland. The flood model will automatically make the line shore normal or perpendicular to the shoreline.

HAZUS allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking the **Draw** button, the tool gets set to the 'Line' tool, and the customization gets locked, therefore users will not be able to select any other tool until the Startline, Endline, and Breakline(s) are drawn.

The user can move the startline if the initial effort is not in the right location by merely reselecting the **Draw** button and drawing the startline in another location. Similarly, if the user decides not to change the startline after having drawn one, the user can click on the **Use Default** button and restore the Shore Startline to its default location.

Clicking on the **Use Default** button will only restore the active Limit Type such as the Startline or the Endline. To restore both the Startline and the Endline the user needs to select the radio button and click on the **Use Default** Button for each line.

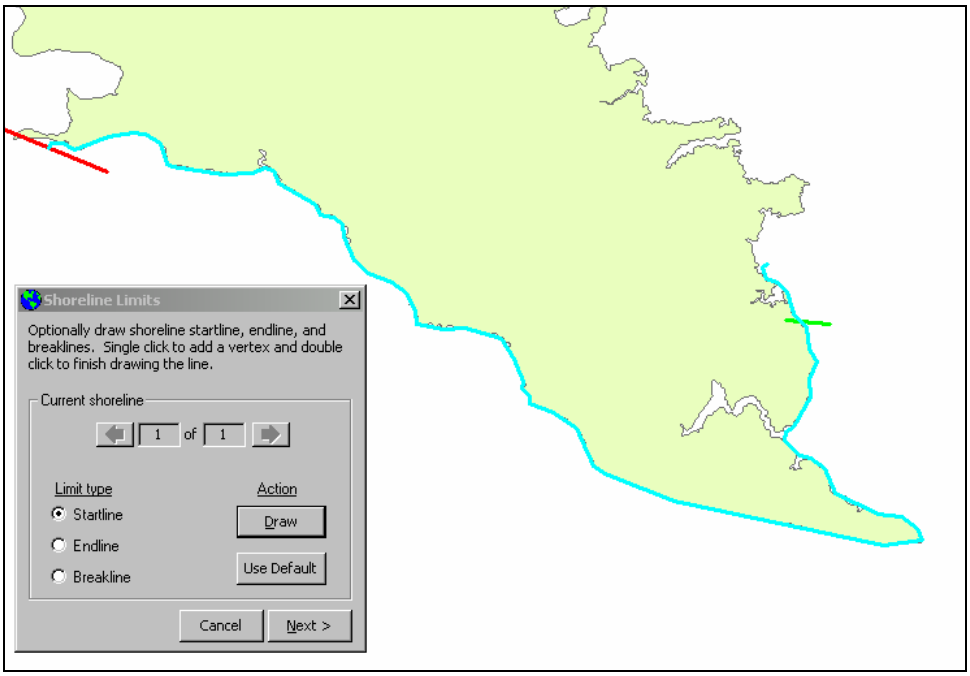


Figure 3.70 Resetting the Shoreline Start Line

An example of changing the shoreline end (endline) can be seen in Figure 3.71 below. In a similar fashion, the user can change the location of their endline by clicking on the **Draw** button and drawing a new line. To restore the default, the user needs to click on the **Use Default** button with the Endline radio button enabled.

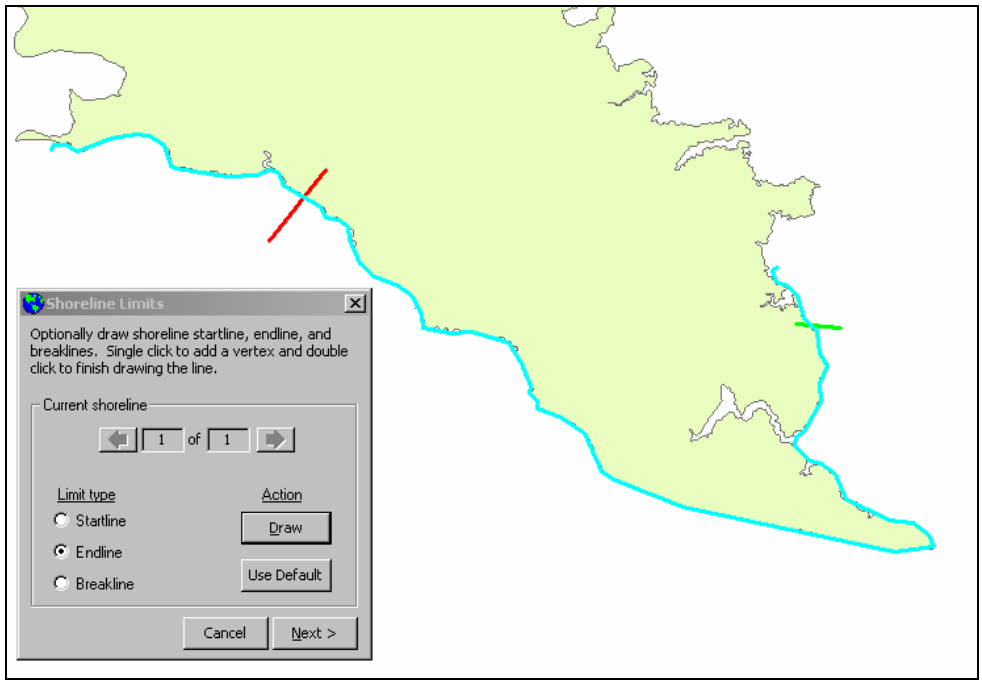


Figure 3.71 Resetting the Shoreline End Line

As stated previously, if the study region shoreline has differing geography, the user will want to segment the shoreline and classify the shoreline into the proper geophysical properties. Segmenting the shoreline means that the user will need to select the Breakline radio button and select **Draw**. As with the Startline and the Endline drawing, the user will draw a line crossing the shoreline only once. An example of the result is shown in Figure 3.72 below.

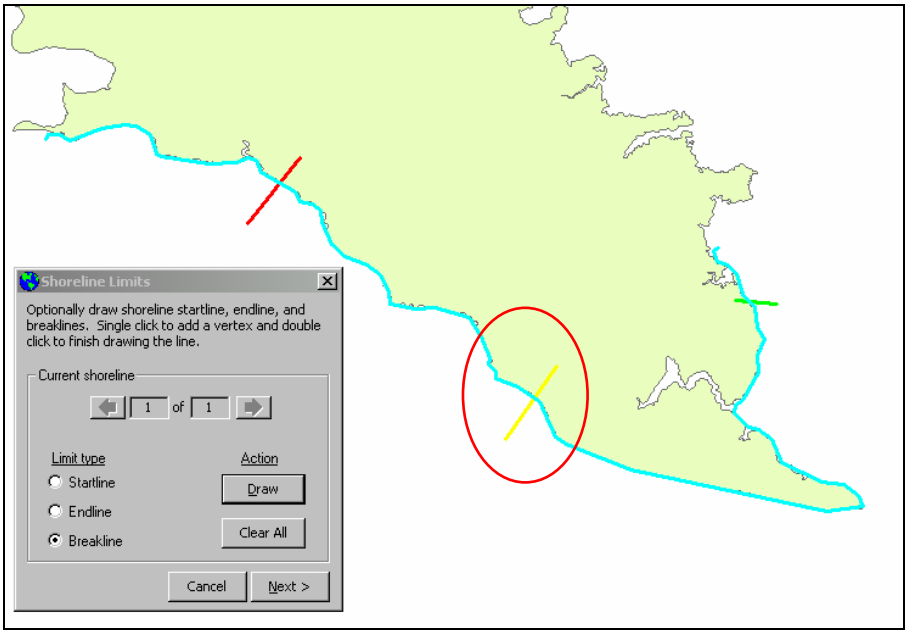


Figure 3.72 Adding a Breakline to the Selected Shoreline

The user cannot change or move a breakline once it has been drawn, to move the line, the user will need to clear the breakline using the Clear All button and redraw the breakline in the new location.

In the case of Figure 3.72 above, the user added a single breakline (circled above) and has decided to progress to the next step. By selecting **Next>**, the user will move to a dialog that obtains needed information regarding the shoreline characteristics, wave exposure and 100-year still water elevation.

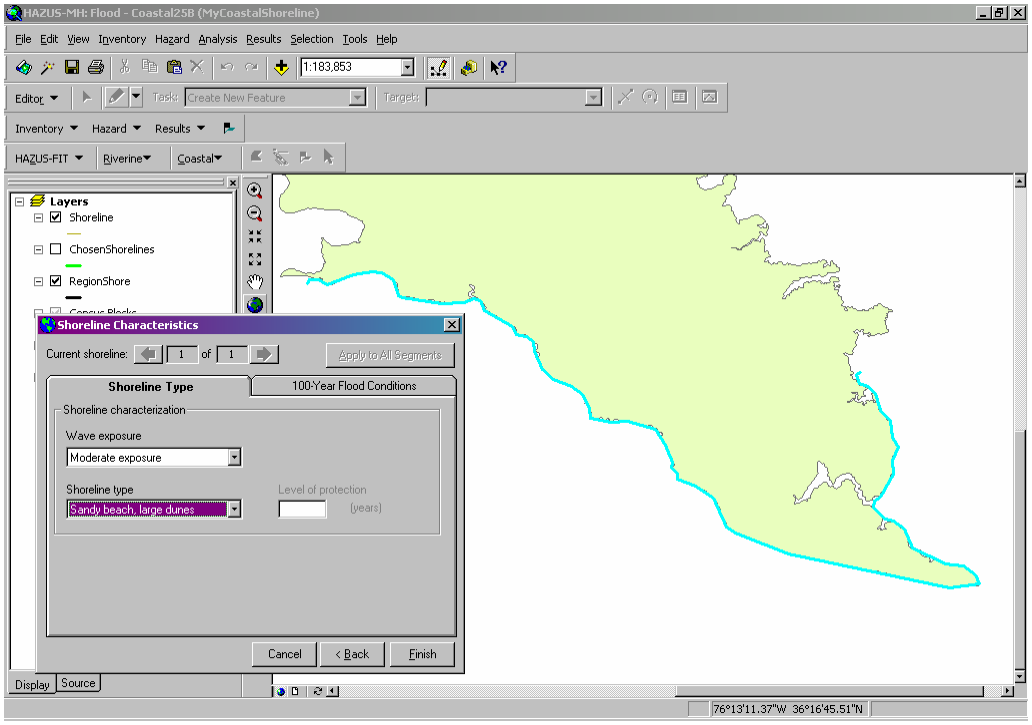


Figure 3.73 Shoreline Characterization – Shoreline Type Tab

The Shoreline Type tab has two input requirements from the user. The default parameters are Moderate wave exposure and Sandy Beach with Large Dunes. The options for the wave exposure include:

- Open Coast (full exposure): This would be any shoreline where the storm surge and waves come directly off open waters without the benefit of any barrier islands or other land mass protection. Think in terms of lines of waves marching directly onto the shoreline uninterrupted.

- Moderate exposure: This is best represented by a shoreline that is slightly protected from the storm surge and associated waves. This might be a shoreline that has some small islands or a low-lying sandbar that helps break the direct force of the waves on the shoreline. This shoreline might be angled somewhat to the direct line of the waves and therefore receiving a portion of the wave front. This is the **HAZUS** default.

- Minimal exposure: This is best represented by a shoreline that is not in direct line with the storm surge or the waves. This might include an exposed shoreline that is running somewhat parallel to the storm surge and therefore is not bearing the brunt of the wave fronts.

- Sheltered: This is best represented by the shoreline within a bay or protected by a larger barrier island. This could also be a shoreline along a large river inlet. The shoreline is sheltered from the wave front and is most likely subjected to still water flooding.

The dialog also contains a combo box that allows the user to identify the geophysical properties of the shoreline. As mentioned previously the options in this combo box includes:

- Rocky Bluffs: This is best represented by the shoreline along California's north coast where the shoreline rises nearly vertically out of the ocean. Shore erosion, WHAFIS (Wave Height Analysis for Flood Insurance Studies), and runup are not run on this type of shoreline.

- Sandy bluffs, little beach: This is best represented by coastal areas near Malibu, California where the bluffs are can be eroded and the beach is very small. WHAFIS is not run on this type of shoreline but runup is analyzed and coastal erosion is checked.

- Sandy beach, small dunes: This is best represented by some of the shorelines along the Gulf of Mexico where the shoreline can be a long sandy beach with small frontal dunes. This type of shoreline will be analyzed for erosion, WHAFIS, and runup

- Sandy beach, large dunes: This is best represented by the Carolina barrier islands where the beach can be large and have a high frontal dune that may be capable or resisting larger storm surges. For this type of shoreline, erosion, WHAFIS, and runup are analyzed.

- Open wetlands: This can be represented by some areas of the Carolina barrier islands, where the marshes or other wetland areas buffer the sand and prevent erosion. WHAFIS, runup and erosion are analyzed for this type of shoreline.

- Erosion protection: Selection of this shoreline type enables the Level of Protection input box and the user is required to define the level of protection in terms of return intervals. An example might be a floodwall engineered to withstand a 100-year storm surge. The flood model does not run any special analysis such as WHAFIS, Runup or erosion, but Stillwater flooding will be examined since water may have other avenues behind the protection. If the return interval is exceeded, the flood model will assume the erosion protection has failed and the shoreline will be eroded.

At the top of the dialog, the user can switch from one shoreline segment (if more than one) to another and back. If there are multiple segments and most have a single characteristic and a few with unique characteristics, the user can save time and effort by applying the common characteristic to all segments and then edit those unique segments.

The second tab of the shoreline characterization dialog is shown in Figure 3.74.

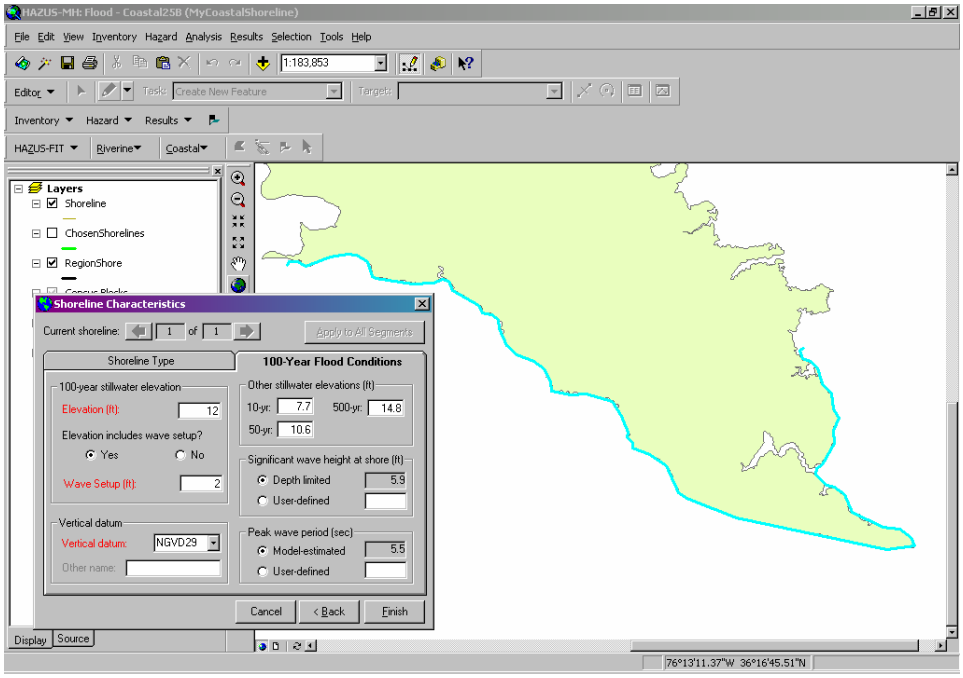


Figure 3.74 Shoreline Characterization – Stillwater Flood Conditions Tab

In order for the coastal analysis to have a starting point, the user must provide the 100-year still water elevation from a Flood Insurance Study. This information is readily available online at the FEMA Map store at http://store.msc.fema.gov/. The following figures give the user an idea of how the data can be captured from the FEMA web site. Remember that internet websites are constantly being changed and the look and feel may no longer be exactly the same as seen in Figure 3.75 through Figure 3.79. Figure 3.79 has been rotated 90 degrees for clarity.

Figure 3.75 FEMA Map Store Welcome Page and Map Catalogue Screen

Figure 3.76 Selecting the State or Territory and County or Parish

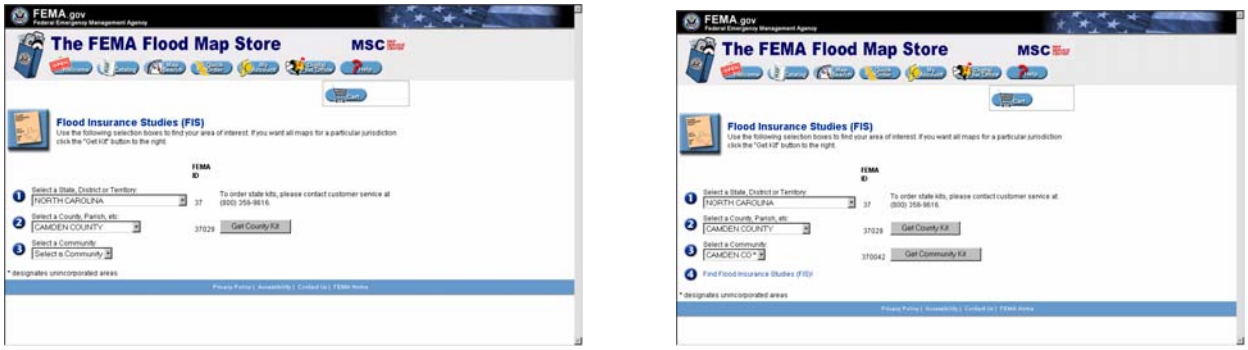


Figure 3.77 Selecting the Community and Preparing to "Get" the FIS

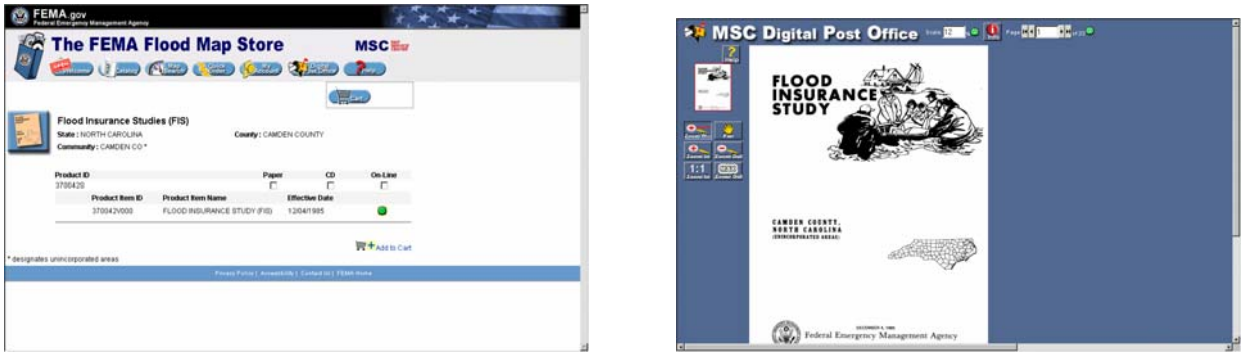


Figure 3.78 Flood Insurance Study Listing (if more than one) and the Selected FIS

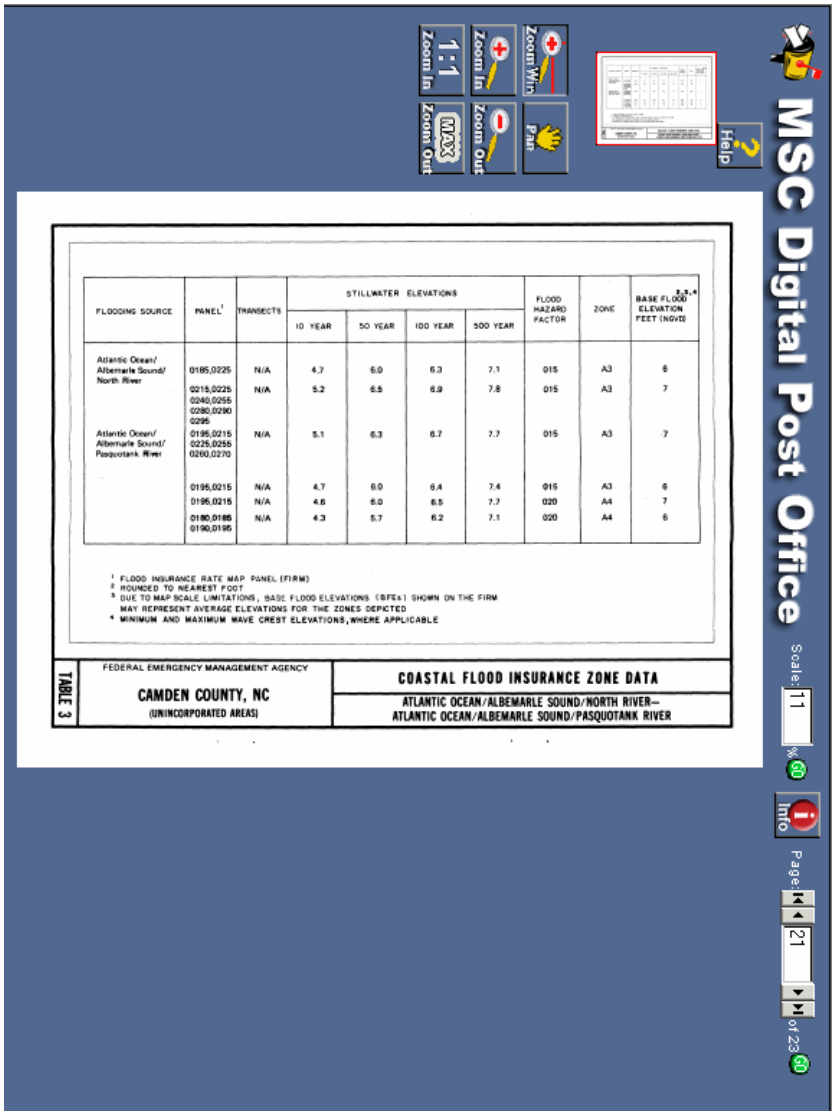


Figure 3.79 FIS Page with Still Water Elevations (image rotated 90 degrees)

Once the FIS has been obtained, the user can input the value in the Elevation field. This field and the vertical datum field are required. The other still water elevation boxes are calculated using the standard FEMA ratios, but can be edited and overwritten by the user if the data is available within the FIS.

The user should review the FIS carefully to determine if the 100-year SWL includes wave setup. If it does, the user should put in the 100-year still water elevation as noted in the FIS, but must also check the **Yes** radio button under the "*Elevation includes wave setup?*" question. Doing this will enable the **Wave Setup (ft)** text box and the user should enter the wave setup value here. If the user cannot identify if wave setup is included, quickly graph the stillwater elevations listed in the FIS and see if the 100-year SWL is higher than expected by the graph. If so, it most likely includes wave setup.

Fields that require data input in order for a coastal analysis to be performed are in red text. Other fields are automatically loaded with default parameters or do not need to be completed.

Once the user has completed inputting the required information on both tabs of the shoreline characterization dialog the process is completed and the flood model has the necessary data to perform a coastal analysis for any given return interval.

3.3.7.2 Delineate Floodplain – Coastal Hazard

Under the *Hazard* menu, *Coastal* submenu, the user will see the *Delineate Floodplain* option enabled. Selection of this option will open a dialog that allows the user to select their hazard analysis options. At the bottom of the window, HAZUS will indicate how much virtual memory is available on the machine and the estimated virtual memory that will be used for the coastal analysis. Figure 3.80 below shows the Coastal hazard analysis dialog.

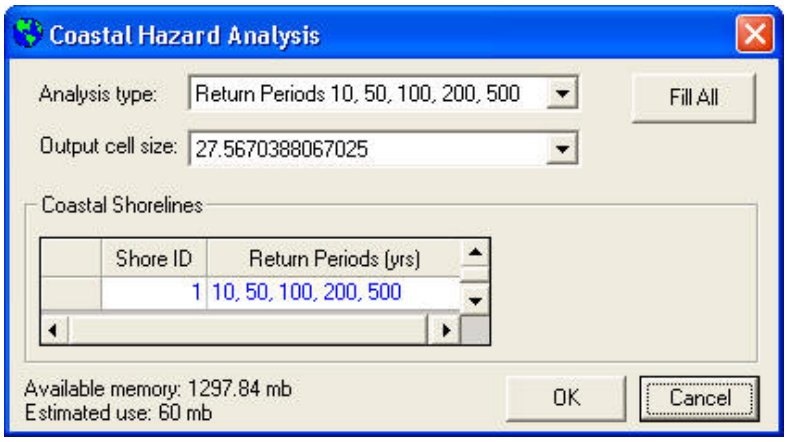


Figure 3.80 Calculate Hazard – Coastal Hazard Options

The coastal analysis has three options available to the user:

1. Selecting *Return Periods 10, 50, 100, 200, 500* will calculate flood depths and floodplains for the 10-year, 50-year, 100-year, 200-year and 500-year return period floods the entire shoreline in your scenario. The flood model will produce a single 10-year flood depth grid for shoreline. This process is duplicated for the other four return intervals.

2. Selecting *Specific Return Period* lets you specify any flood return period for which the flood characteristics will be calculated. Unlike riverine, you cannot choose different return periods for different shoreline segments. The results will be a grid of flood depth for the selected return period.

3. Selecting *Annualized Loss* will calculate a suite of floods to be used later in an annualized loss calculation. The annualized loss menu item on the *Analysis* menu will become enabled when this has been completed.

When running hydraulic analysis, the HAZUS screen might go blank or the Task Manager "Applications" tab will indicate that HAZUS is not responding. This is a common symptom for any software that is process heavy. In order to check if HAZUS is still running, users should check the Task Manager "Processes" tab and sort the "CPU" column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99-100%, this is a clear indication that HAZUS is not responding. Users could also check the "Performances" tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the scenario folder (in "Details" view) and make sure the FlHydraulicsLog is updating by looking at the "Date modified."

3.3.8 Riverine and Coastal

The primary reason the user is asked to select between *Riverine Only*, *Coastal Only*, or *Riverine and Coastal* is to limit the DEM requirements for the user. Selection of *Riverine and Coastal* on the Hazard Type dialog will require the user to get a DEM that supports the analysis for both hazard types. Once the user has provided the DEM, they are free to perform any of the hazard analysis. For example, if the user selects *Riverine and Coastal*, they will be required to build the *Stream Network* and the shorelines will already be available to the user. During the creation of scenarios, the user will have the option to build a scenario with only river reaches, only shorelines, or a combination of reaches and shorelines. The flood model maintains the riverine and the coastal hazard depth grids separately because the depth of flooding alone does not determine which hazard is producing the most damage by occupancy.

If the user has chosen to run a scenario with river reaches and coastal shorelines, the flood model will analyze the impact of both hazards on the inventory independently and then compare the resulting losses to see which hazard is the controlling hazard, or the hazard with the greatest impact on that occupancy or structure.

To perform a combined analysis, the user should perform the following steps:

1. Create Stream Network (required),

2. Create Scenario and select river reaches and shorelines – Note: the user should select the Riverine and Coastal radio button to ensure that both layers are selectable.

3. Characterize the shoreline

4. Run hydrology
5. Delineate floodplain (riverine)
6. Delineate floodplain (coastal)

Once the user has completed this effort, they are ready to perform the hazard "*What-ifs*" or go onto the *Analysis* menu.

3.3.9 Using Hazard What-Ifs

The Flood Model Oversight Committee identified specific items that they believed would enhance the user community acceptance of the flood model. These capabilities provided a level of "What-if" functionality to the user allowing them to utilize the flood model as a planning tool. The flood model "what if" scenarios include riverine levee, riverine flow regulation, riverine velocity, coastal long-term erosion, and coastal shore protection. The following sections provide a description of the process to generate the hazard (depth grid) for the what-if analysis.

Use of What-If scenario functionality requires that the flood hazard has already been computed. Levee, flow regulation, and velocity analysis require the Riverine hazard to be completed. Long-term erosion and shore protection routines require the coastal hazard to have been completed.

3.3.9.1 Riverine Levee

In general, DEMs are not reliable for identifying a continuous embankment with relatively little width. Because grid cells are connected at the corners as well as the sides, an embankment that is not a straight line, in the strictest sense, must be at least two cells wide to be treated as a barrier to flow. A tool is available in **HAZUS** to add a levee alignment, attribute the levee with a level of protection and, for level 1 analyses determines the effects of a levee on flood depths within the unprotected portion of the floodplain.

Select *Riverine* from the *Hazard* menu. On the sub-menu, select *Levee*. The levee option is drawn with the mouse after clicking the **Draw** button. Flood depth grids have been created for the reach and the user chooses a grid on which to draw the levee alignment. The alignment should cross the floodplain twice. Then enter the recurrence interval, in years, corresponding to the level of protection provided by the levee and click **OK**.

HAZUS allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, the tool gets set to the 'Line' tool, and the customization gets locked, therefore, users will not be able to select any other tool until the levee is drawn.

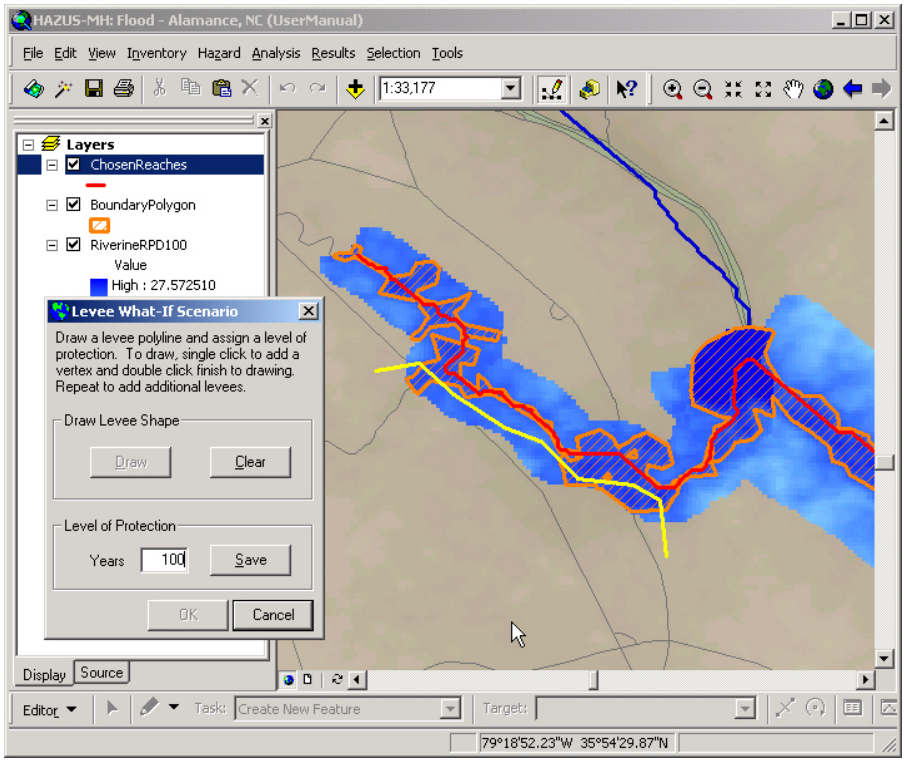


Figure 3.81 Riverine Levee

The model then enforces the levee into the DEM and the flood hazard for the scenario is recomputed.

3.3.9.2 Riverine Flow Regulation

The default hydrologic analyses apply to unregulated drainage areas. Regulation, through diversions and/or storage, changes the flood frequency curves downstream. **HAZUS** provides a tool for incorporating the downstream effects of flow regulation. The tool allows users to modify the unregulated flood frequency curve at a specific location by entering one or more pairs of recurrence intervals and discharge values. **HAZUS** identifies downstream reaches affected, and modifies the corresponding flood frequency curves as appropriate, prior to re-computing the flood hazard.

Select *Riverine* from the *Hazard* menu. On the sub-menu, select *Flow Regulation*. Click the **Draw** button to identify the location of a regulating structure, such as a flood control reservoir. Upon clicking the **Apply** button, the algorithm finds the drainage area upstream of that location and defines the unregulated flood frequency curve. The curve is plotted and a table of recurrence intervals and associated discharge values is presented for the user. Enter the return period and discharge of the regulating structure and click **OK**.

HAZUS allows users to zoom in and out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, users will not be able to select any other tool until the regulation structure is drawn.

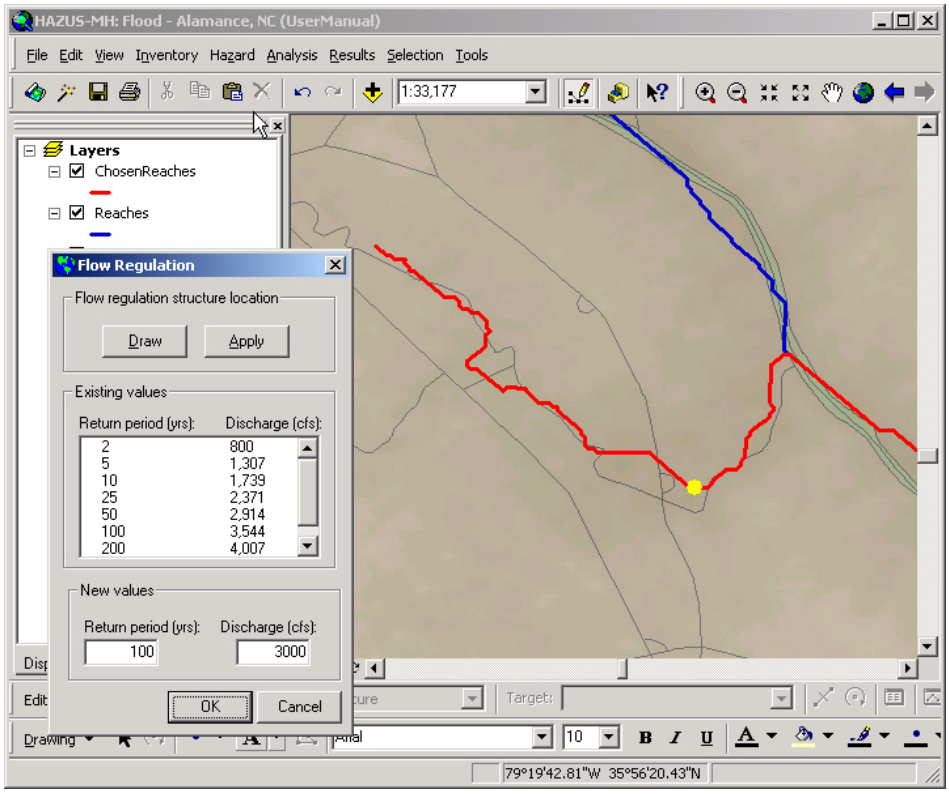


Figure 3.82 Riverine Flow Regulation

3.3.9.3 Riverine Flow Velocity

The velocity of floodwater can contribute to the flood hazard by carrying large amounts of sediment and debris, impacting structures, and eroding soil from stream banks and under foundations. In the velocity analysis, the spatial distribution of the floodwater velocities is estimated.

Select *Riverine* from the *Hazard* menu. On the sub-menu, select *Velocity*.

3.3.9.4 Coastal Long-Term Erosion

Long-term erosion can be a consequence of a number of factors at a site (e.g., storms, interruptions, in long-shore sediment transport, sea level rise, human activities). The purpose of the long-term erosion scenario is not to determine causation, but to estimate the effects of long-term erosion on coastal flood hazards.

Select *Coastal* from the *Hazard* menu. On the sub-menu, select *Long Term Erosion*. Enter the rate and duration of erosion in the text boxes. To enter values for a different shoreline, change the current shoreline by clicking on the previous or next arrow. Click OK after the values for all shorelines have been entered.

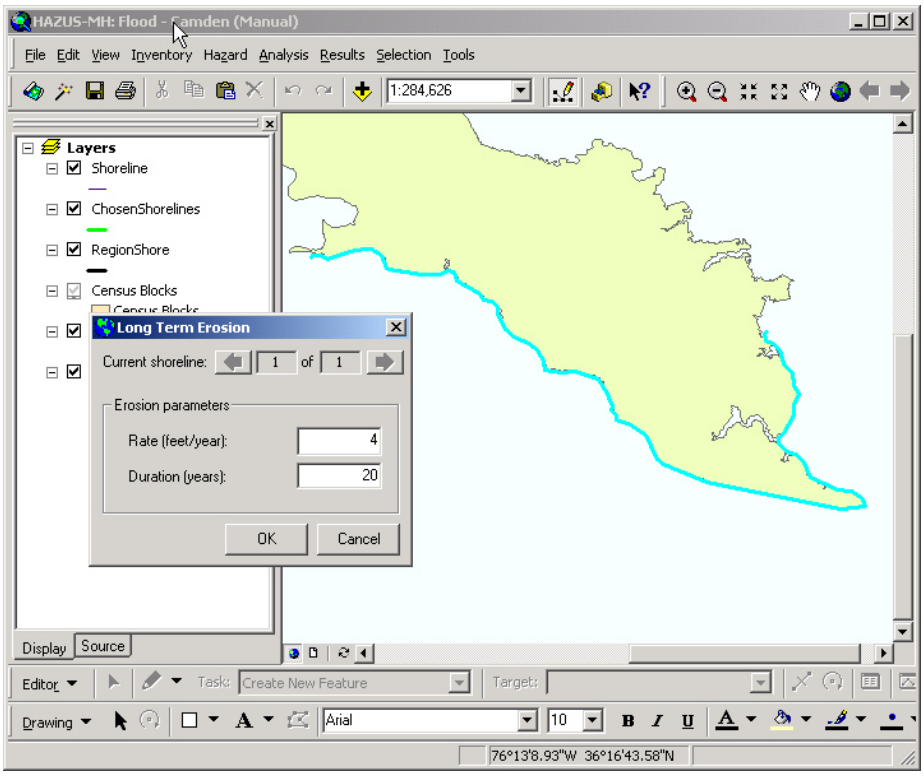


Figure 3.83 Coastal Long-Term Erosion

3.3.9.5 Coastal Shore Protection

The shore protection scenario allows users to modify the type of one or more shorelines. The analysis assigns protection to the selected shorelines that prevents erosion and wave effects from propagating landward of the shoreline. However, the analysis does not preclude potential stillwater flooding landward of the shoreline.

Select *Coastal* from the *Hazard* menu. On the sub-menu, select *Shore Protection*. With the **Select** button, highlight the shoreline(s) to be protected from erosion and wave action. Click the **OK** button and the coastal flood hazard will be recomputed.

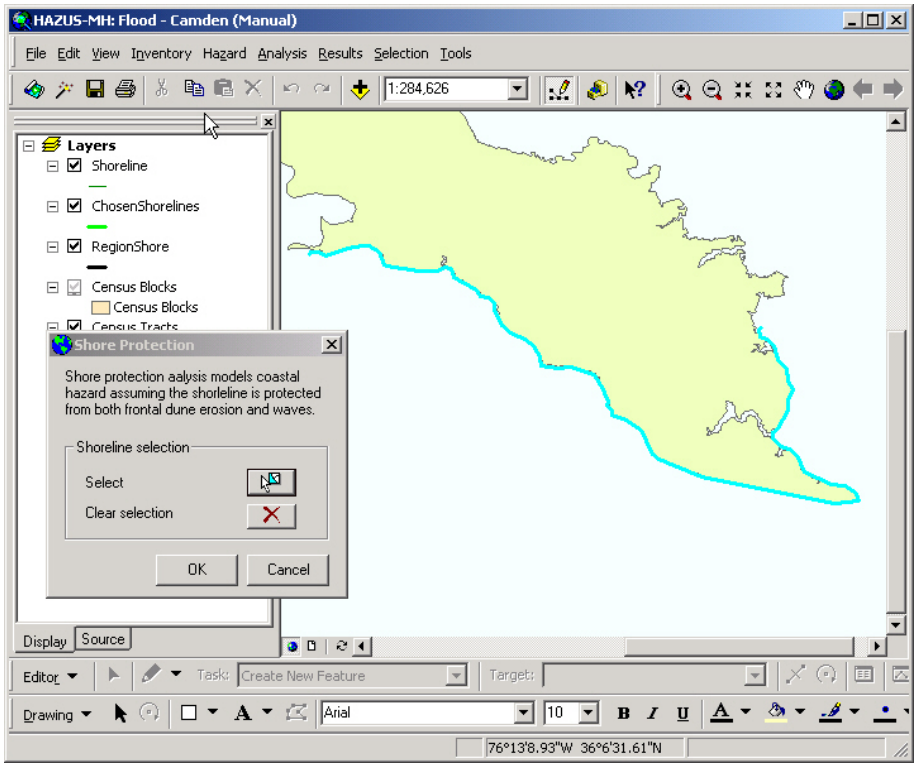


Figure 3.84 Coastal Shore Protection

3.3.10 Using Quick Look

The Quick Look feature allows the user to quickly produce a rough estimate of flood damages, without working through the process of generating a stream network or Delineate Floodplain. Instead of generating a floodplain associated with a specific return period or rainfall amount, Quick Look lets the user enter an anticipated flood depths for an area of their selection. Then, based on the infrastructure present in the area you select, approximate damages are estimated.

The Quick Look analysis is only performed on the General Building Stock (GBS). The GBS results tables are populated and a summary report uniquely developed for the Quick Look is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

Quick Look is only appropriate for small areas with similar elevations. The Quick Look function assumes a standard depth of water over the entire area you select, and does not use any topology (DEM) or check for the veracity of the flood depths input by the user. If you select an area with significant elevation gradations, Quick Look will assume that high elevation locations have the same level of flood depth as low elevation locations, which would produce meaningless results. The Quick Look does allow the user to create multiple polygons with differing flood depths.

Select *Quick Analysis* from the *Hazard* menu and select *Quick Look* from the submenu. Click on **Draw** in the window that pops up. Using the cursor, draw a polygon with as many sides as you

wish, illustrated in Figure 3.85. Double-click when you have selected the area you wish. Next, enter a flood depth for the polygon you have selected. Click **Save**, then click **OK**.

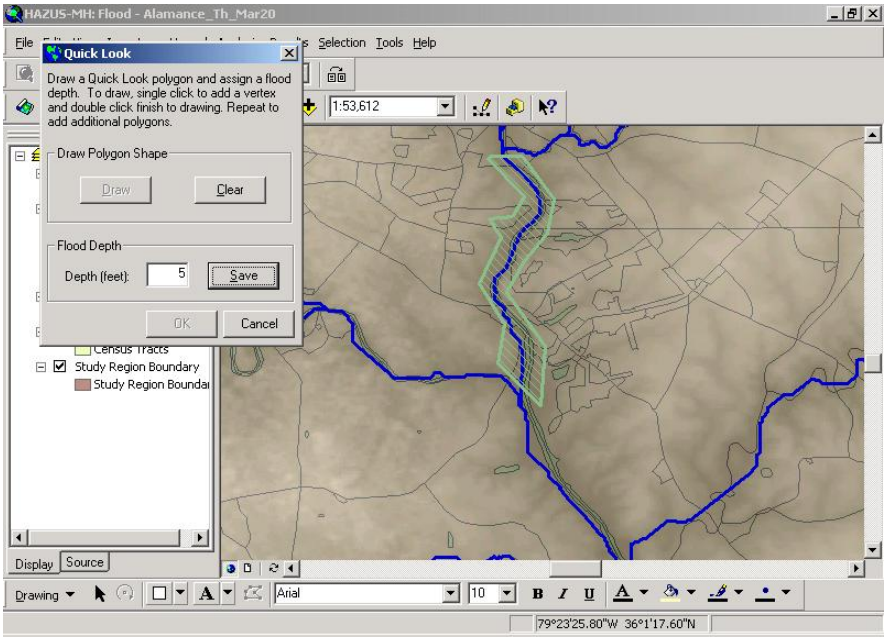


Figure 3.85 Drawing a Polygon for Quick Look

Only one quick look analysis can be performed in a given study region. Additional quick look analysis efforts will over write the results from the previous analysis. Quick Look will not run if a scenario is open. It is independent from the scenario(s).

HAZUS allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, users will not be able to select any other tool until the polygon is drawn.

3.3.11 Using Enhanced Quick Look

Similar to the Quick Look function, Enhanced Quick Look is an analysis option where the user is providing a polygon that represents the floodplain boundary. HAZUS will estimate the flood depth within that boundary. The analysis performed is therefore based on this user supplied anecdotal information and should be used with great care.

Select *Quick Analysis* from the *Hazard* menu and select *Enhanced Quick Look* from the submenu. A window will pop up and ask the user to select the Vertical Units and Vertical Datum of the polygon. Users will also have to browse to the appropriate location for the DEM and floodplain boundary polygon, as illustrated in Figure 3.86. The analysis will start as soon as the user clicks **OK**.

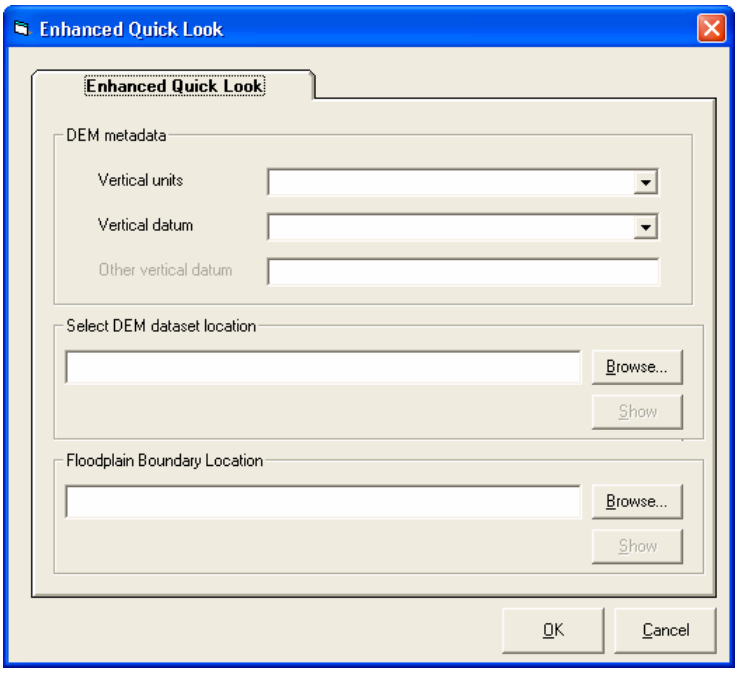


Figure 3.86 Enhanced Quick Look

Only one enhanced quick look analysis can be performed in a given study region. Additional quick look analysis efforts will over write the results from the previous analysis. Enhanced Quick Look will not run if a scenario is open. It is independent from the scenario(s).

3.4 Running an Analysis Using Default Data

In a **HAZUS** loss analysis, the characteristics of the structures and people of the study region are analyzed for vulnerability to the flood or floods, which have been calculated in your scenario. Default damage functions, which estimate percent damage relative to the depth of floodwater as measured from the top of the first finished floor (riverine) or bottom of the first flood (coastal), are provided with the **HAZUS** program. Other damage functions were collected or developed for vehicles, riverine velocity, utility components, and transportation bridges.

3.4.1 Viewing Damage Functions

Under the *Analysis* menu, you can view the functions that will be used to estimate damage of various types. This section looks at one set of those functions, and you are encouraged to familiarize yourself with all of them.

Selecting *Buildings* from the *Analysis* menu *Damage Functions* submenu, the window shown in Figure 3.87 appears. This table provides information on the default damage function associated with each specific occupancy class (e.g., RES1) and subclass (e.g., RES1, 1 story, no basement). By scrolling to the right in this window you will see the percent of damage, expressed in terms of

building replacement cost, estimated at different water depths. The pull-down menus at the top of the window allow you to view the default damage functions for the coastal hazard and other occupancy classes such as COM1. Clicking on the different tabs at the top (Structure, Contents, Inventory) allows you to view default damage functions associated with building structures, and their contents for all specific occupancy types, and inventory for selected occupancies (e.g., COM1, IND1-6 and AGR1).

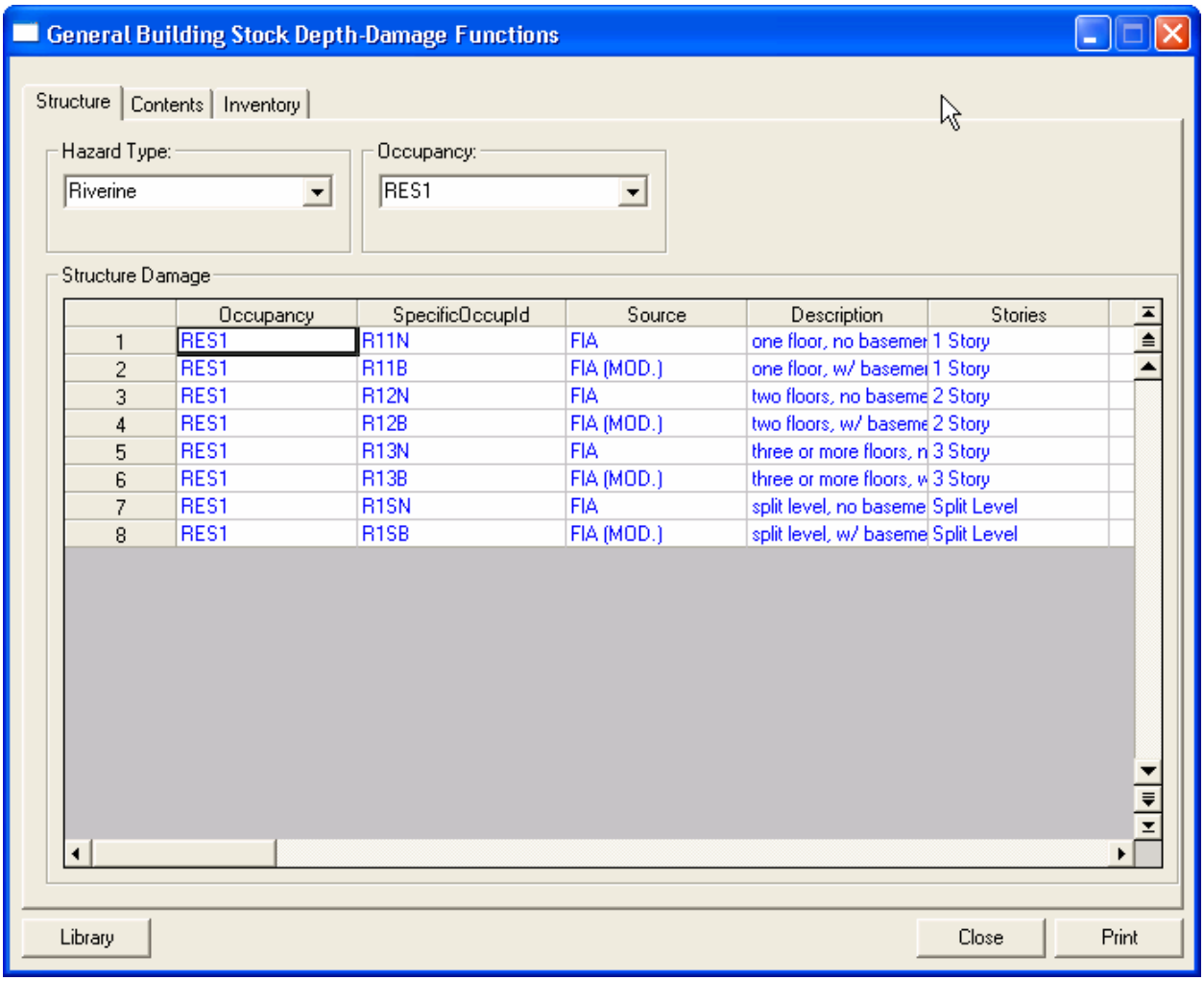

General Building Stock Depth-Damage Functions
Structure
Contents
Inventory
Hazard Type:
Riverine
Occupancy:
RES1
Structure Damage
Occupancy
SpecificOccupId
Source
Description
Stories
1 RES1 R11N FIA one floor, no basemer 1 Story
2 RES1 R11B FIA (MOD.) one floor, w/ basemer 1 Story
3 RES1 R12N FIA two floors, no baseme 2 Story
4 RES1 R12B FIA (MOD.) two floors, w/ baseme 2 Story
5 RES1 R13N FIA three or more floors, n 3 Story
6 RES1 R13B FIA (MOD.) three or more floors, w 3 Story
7 RES1 R1SN FIA split level, no baseme Split Level
8 RES1 R1SB FIA (MOD.) split level, w/ baseme Split Level
Library
Close
Print

Figure 3.87 Building Depth-Damage Functions by Occupancy (Riverine)

If you click on the *Library* button at the lower left of the window, Figure 3.88 will appear on your screen. Viewing the library of damage functions allows the user to review other damage functions applicable to the occupancy under consideration relative to the current default, as well as replace the current default with another function from the library.

The library dialog makes heavy use of color codes to help the user identify any changes and selections they may make in the dialog. The Library dialog is composed of three windows.

The left window is the navigation window where the user can change between occupancies, foundation heights and number of stories. This window allows the user to select a specific occupancy (e.g., RES1) and shift through the potential foundation types (slab on grade, fill, basement, crawlspace, pier, post, and pile) and number of stories typical for the selected specific occupancy (1-story, 2-story, 3-story, split level for residential and low, mid, and high rise for non-residential) within that occupancy. The sub-occupancies displayed in the window are a form of shorthand that identifies the occupancy class. The short hand was developed by taking the first letter and numeric values of the specific occupancy name (e.g., RES1 becomes R1 and COM10 become C10), this is concatenated with the value for the number of stories (e.g., 2-story becomes 2 and Low rise becomes L), and finally the existence of a basement derives the last value (e.g., structures with a basement get a B and structures without get an N). Therefore a the residential occupancy classified as RES1 with 1-story and no basement becomes R11N while the commercial occupancy classified as COM10, mid-rise, with a basement become C10MB

The bottom right grid is where the library of damage functions is displayed for the user to view and/or select. The user can browse between damage functions for the foundation and number of stories by selecting the sub-occupancies in the left column grid. In this case, Figure 3.88 is displaying all of the functions available for the sub-occupancy R11N (RES1, 1 Story, with no basement). Selection of C10MB (COM10, mid-rise, with basement) would display an entirely different set of damage functions in the grid on the lower right.

Finally, the window in the upper right is used to allow the user to make comparisons and selections among the damage functions. The first row in the grid will always display the **HAZUS** default function in red. The second line in the upper right grid displays the “current” function or any damage function that the user has highlighted in the lower window. To help the user view the current function, it is also displayed in green text. The user may want to use the “current function” line as a way of displaying a function and directly comparing it to the default damage function. Figure 3.88 is currently displaying a USACE New Orleans District damage function (highlighted row 10) for RES1, 1-story slab on grade. The third row in the upper right grid displays any function the user may have “selected” as their damage function. That is, a damage function the flood model will use rather than the default damage function. This is how the user can essentially override the default damage functions with either a library function that they believe better represents their local area, or a custom function they may have built themselves. Figure 3.88 is displaying a USACE New Orleans District damage function (lower right grid, blue text RES1 1-story, pier foundation) that was selected in place of the default function.

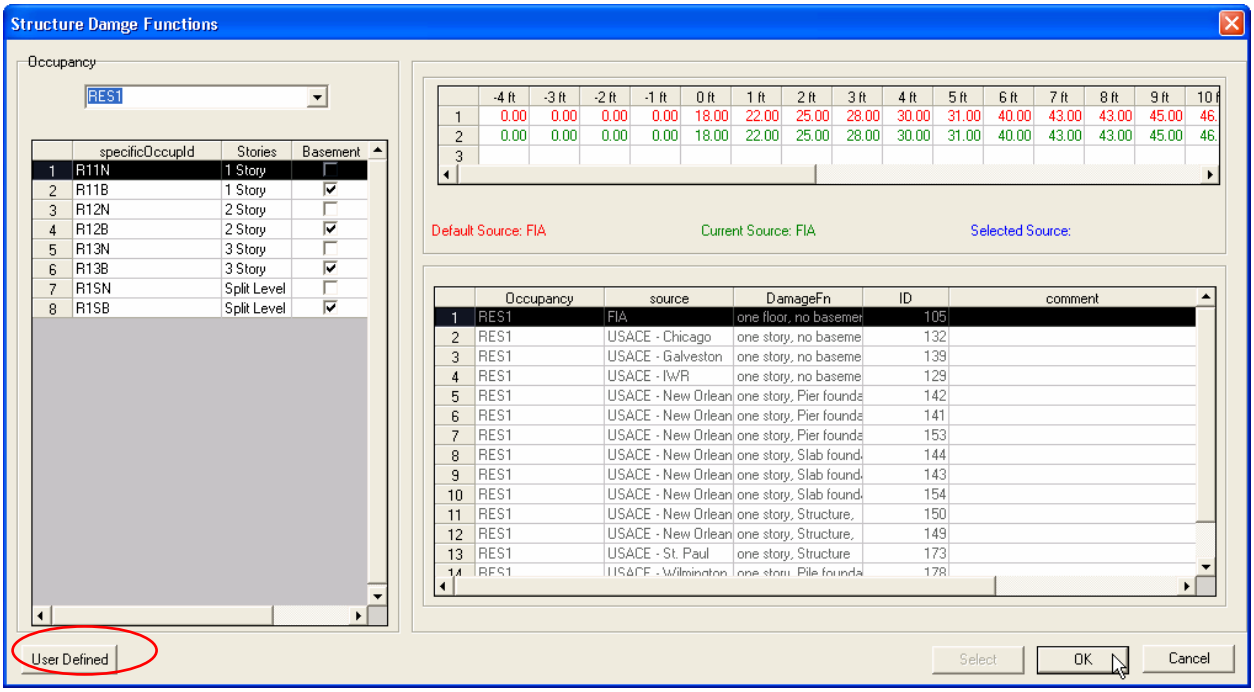


Figure 3.88 Building Depth-Damage Function Library

If the user chooses, they may use one of the library functions to build their own custom damage function. To do this, the user would click on the User Defined button in the lower left corner of the dialog (circled). When the user selects this button, the flood model takes the highlighted damage function, if any, and opens an editable dialog for the user to make modifications. Figure 3.89 shows the dialog. The flood model inserts the damage function description from the starting damage function the user selected (or the default damage function if none is selected) and adds a comment that identifies for the user what the original source damage function was. This will allow the user to maintain some idea of where they started the process. The user is required to enter a source (or name) for the damage function. It is recommended that the user do not edit the Comment or description.

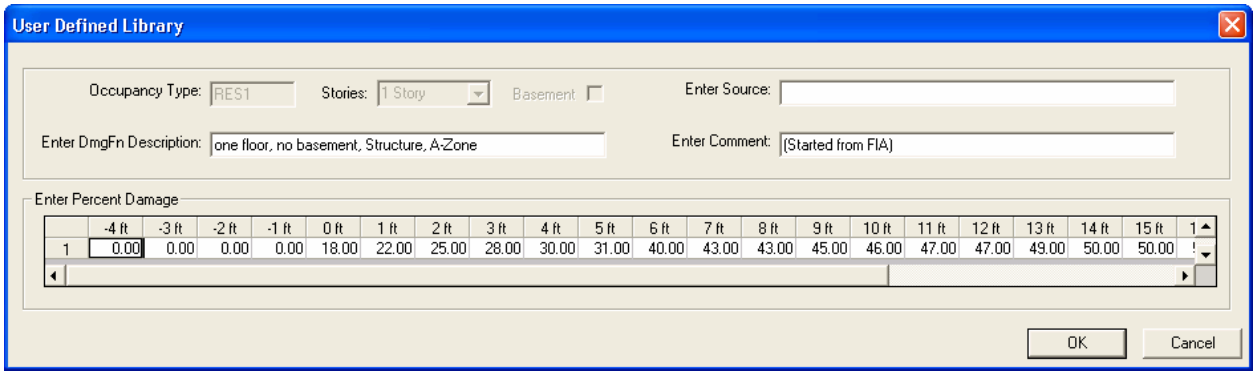


Figure 3.89 Editing Dialog for User Defined Function Development

If the user has decided to select a new damage function for use in the flood model, the entry dialog will highlight the damage function to remind the user that a default function is not being used. Figure 3.90 shows how the change would appear in the entry dialog as compared to that seen in Figure 3.87 earlier in this section.

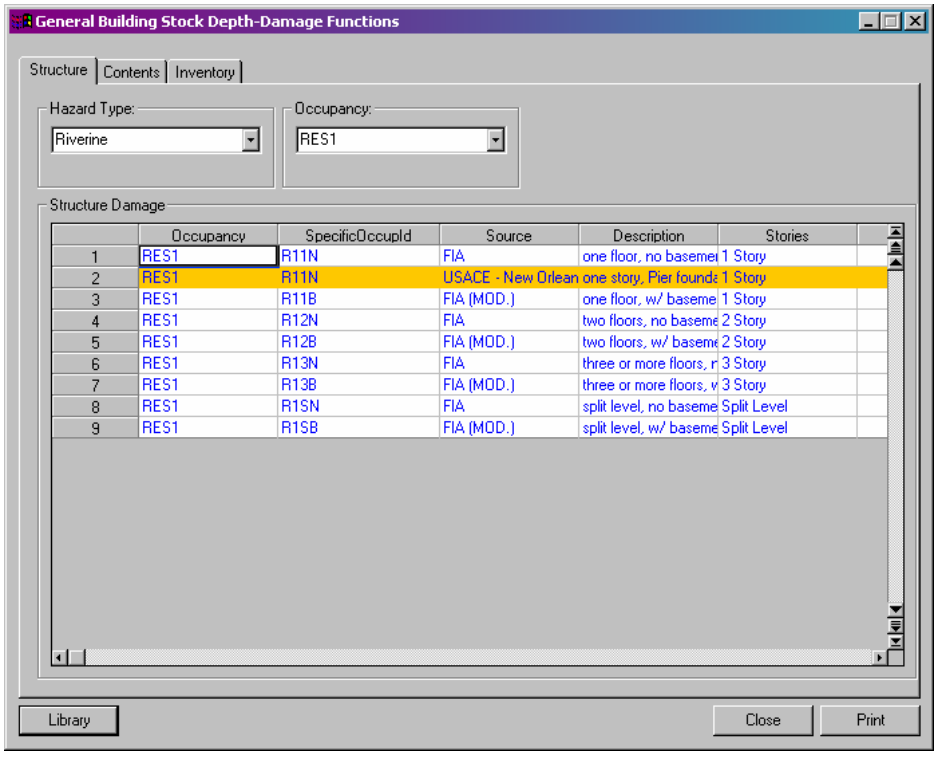

General Building Stock Depth-Damage Functions
Structure
Contents
Inventory
Hazard Type:
Riverine
Occupancy:
RES1
Structure Damage
Occupancy
SpecificOccupId
Source
Description
Stories
1 RES1 R11N FIA one floor, no basemei 1 Story
2 RES1 R11N USACE - New Orlean one story, Pier founda 1 Story
3 RES1 R11B FIA (MOD.) one floor, w/ baseme 1 Story
4 RES1 R12N FIA two floors, no baseme 2 Story
5 RES1 R12B FIA (MOD.) two floors, w/ baseme 2 Story
6 RES1 R13N FIA three or more floors, n 3 Story
7 RES1 R13B FIA (MOD.) three or more floors, v 3 Story
8 RES1 R1SN FIA split level, no baseme Split Level
9 RES1 R1SB FIA (MOD.) split level, w/ baseme Split Level
Library
Close
Print

Figure 3.90 Building Damage Function Dialog with a User Selected Damage Function

Similar default damage functions for other facilities, as seen in Figure 3.91 below. The damage function dialogs for Essential Facilities functions in the same fashion as discussed above for the General Building Stock. In most cases, the damage functions available in the essential facilities dialog area also available for the Government structures in general building stock. The essential facilities dialog does not have an inventory tab since the essential facilities occupancies do not produce inventory for sale.

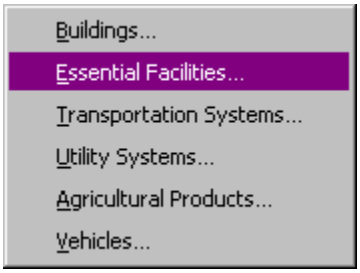
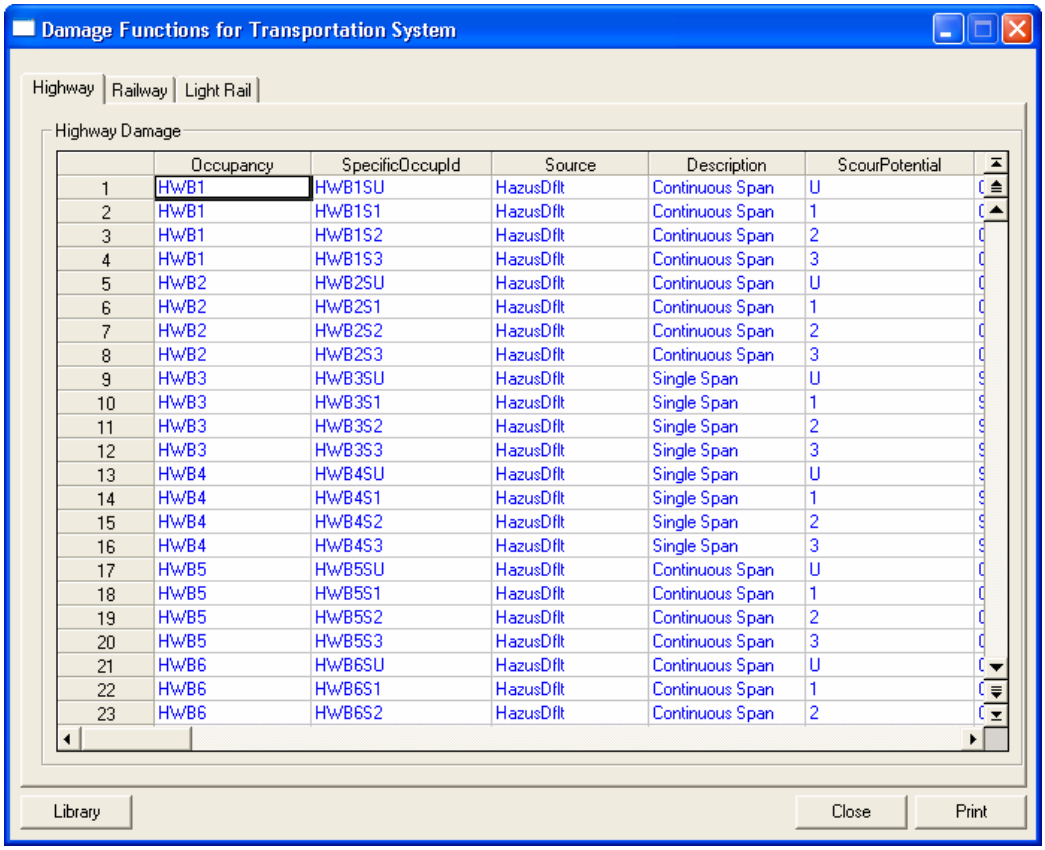


Figure 3.91 Damage Functions Submenu

The Transportation Systems damage function dialog looks slightly different as there is only structure damage function (no contents or inventory) and the dialogs tabs allow the user to shift between Highway, Railway, and Light Rail facilities. Currently the flood model has damage functions for bridges only.

Upon viewing the transportation bridge damage functions, the user will see that they are based on return period. It is important to remember that running an analysis on bridges cannot be done if the user runs mixed return periods on their selected reaches. In other words, if the user assigns a different return period to each reach, or a single discharge on the reaches, the flood model will not be able to analyze the transportation bridges.

The entry dialog for transportation facilities can be seen in Figure 3.92 below.



	Occupancy	SpecificOccupId	Source	Description	ScourPotential
1	HWB1	HWB1SU	HazusDflt	Continuous Span	U
2	HWB1	HWB1S1	HazusDflt	Continuous Span	1
3	HWB1	HWB1S2	HazusDflt	Continuous Span	2
4	HWB1	HWB1S3	HazusDflt	Continuous Span	3
5	HWB2	HWB2SU	HazusDflt	Continuous Span	U
6	HWB2	HWB2S1	HazusDflt	Continuous Span	1
7	HWB2	HWB2S2	HazusDflt	Continuous Span	2
8	HWB2	HWB2S3	HazusDflt	Continuous Span	3
9	HWB3	HWB3SU	HazusDflt	Single Span	U
10	HWB3	HWB3S1	HazusDflt	Single Span	1
11	HWB3	HWB3S2	HazusDflt	Single Span	2
12	HWB3	HWB3S3	HazusDflt	Single Span	3
13	HWB4	HWB4SU	HazusDflt	Single Span	U
14	HWB4	HWB4S1	HazusDflt	Single Span	1
15	HWB4	HWB4S2	HazusDflt	Single Span	2
16	HWB4	HWB4S3	HazusDflt	Single Span	3
17	HWB5	HWB5SU	HazusDflt	Continuous Span	U
18	HWB5	HWB5S1	HazusDflt	Continuous Span	1
19	HWB5	HWB5S2	HazusDflt	Continuous Span	2
20	HWB5	HWB5S3	HazusDflt	Continuous Span	3
21	HWB6	HWB6SU	HazusDflt	Continuous Span	U
22	HWB6	HWB6S1	HazusDflt	Continuous Span	1
23	HWB6	HWB6S2	HazusDflt	Continuous Span	2

Figure 3.92 Transportation Damage Function Dialog

The entry dialog for utility facilities can be seen in Figure 3.93 below. As with the transportation facilities, the tabs allow the user to choose the utility facility for review since there are no contents or inventory functions available.

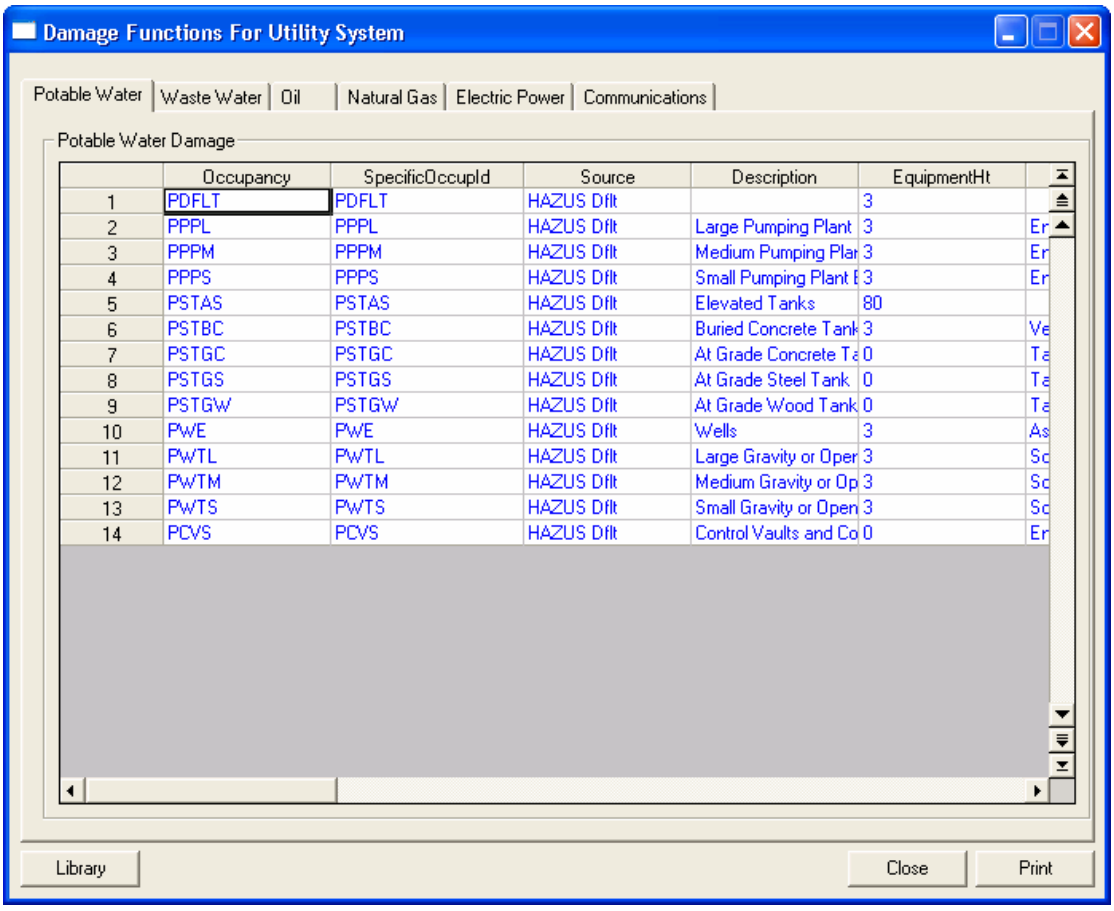
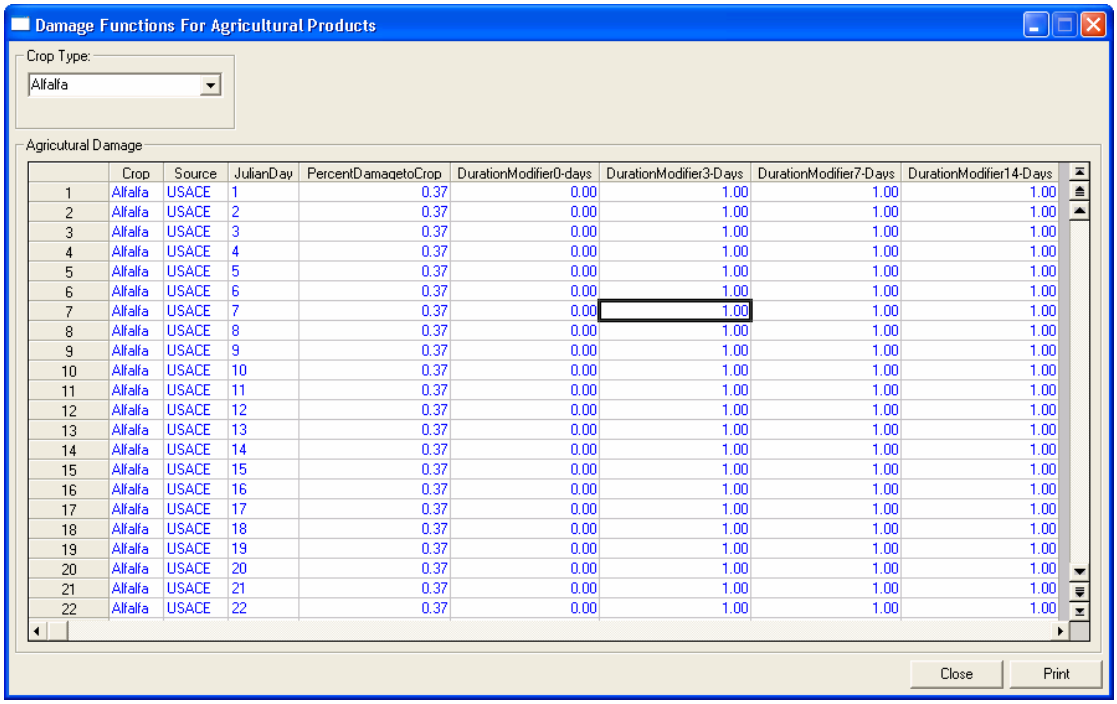

Damage Functions For Utility System
Potable Water
Waste Water
Oil
Natural Gas
Electric Power
Communications
Potable Water Damage
Occupancy
SpecificOccupId
Source
Description
EquipmentHt
1 PDFLT PDFLT HAZUS Dflt 3
2 PPPL PPPL HAZUS Dflt Large Pumping Plant 3
3 PPPM PPPM HAZUS Dflt Medium Pumping Plar 3
4 PPPS PPPS HAZUS Dflt Small Pumping Plant E 3
5 PSTAS PSTAS HAZUS Dflt Elevated Tanks 80
6 PSTBC PSTBC HAZUS Dflt Buried Concrete Tank 3
7 PSTGC PSTGC HAZUS Dflt At Grade Concrete Ta 0
8 PSTGS PSTGS HAZUS Dflt At Grade Steel Tank 0
9 PSTGW PSTGW HAZUS Dflt At Grade Wood Tank 0
10 PWE PWE HAZUS Dflt Wells 3
11 PWTL PWTL HAZUS Dflt Large Gravity or Oper 3
12 PWTM PWTM HAZUS Dflt Medium Gravity or Op 3
13 PWTS PWTS HAZUS Dflt Small Gravity or Open 3
14 PCVS PCVS HAZUS Dflt Control Vaults and Co 0
Library
Close
Print

Figure 3.93 Utility Facility Damage Function Dialog

The Agriculture products damage function dialog behaves similar to the GBS damage function browsers, but has been modified to support the different crops available to the user. The entry dialog can be seen in Figure 3.94 below.

The flood model team gathered a number of damage functions from the US Army Corps of Engineers (UASCE) for various crops. The total number of damage functions available were limited and in some cases functions had to be created to allow the users to work with the top agricultural crops within each state. The damage functions are based on a Julian calendar system. For the users convenience, the flood model makes the conversion between the standard calendar day and month to the Julian date.

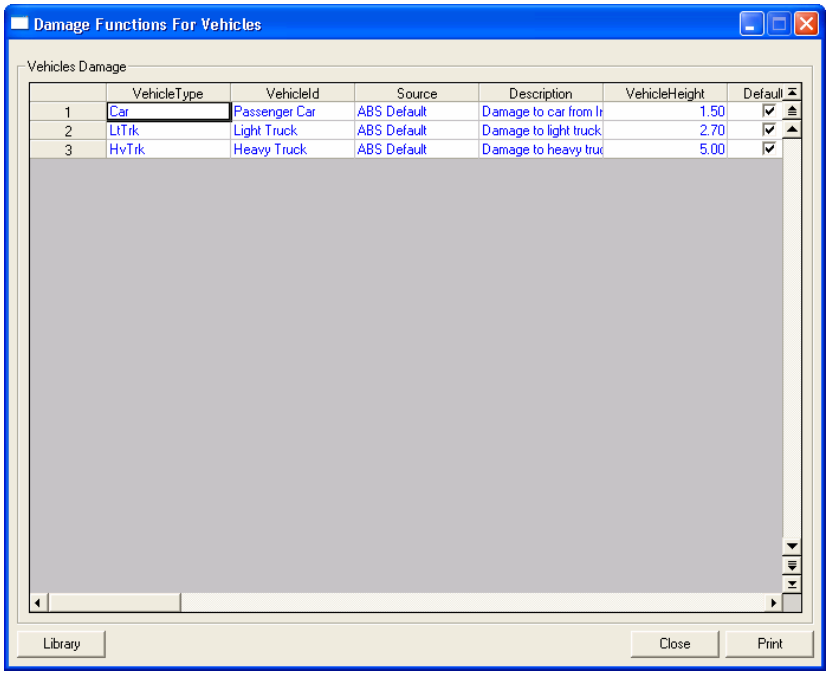
At this time, the flood model assumes a short duration, slow rise flood when analyzing losses. Agriculture crops are particularly sensitive to duration and the functions obtained from the USACE had damage modifiers that allows for the estimation of flood damages should the flood last 0-days, 3-days, 7-days and 14-days. The damage functions all indicate that the maximum damage is obtained at the 14-day interval.



	Crop	Source	JulianDay	PercentDamagetoCrop	DurationModifier0-days	DurationModifier3-Days	DurationModifier7-Days	DurationModifier14-Days
1	Alfalfa	USACE	1	0.37	0.00	1.00	1.00	1.00
2	Alfalfa	USACE	2	0.37	0.00	1.00	1.00	1.00
3	Alfalfa	USACE	3	0.37	0.00	1.00	1.00	1.00
4	Alfalfa	USACE	4	0.37	0.00	1.00	1.00	1.00
5	Alfalfa	USACE	5	0.37	0.00	1.00	1.00	1.00
6	Alfalfa	USACE	6	0.37	0.00	1.00	1.00	1.00
7	Alfalfa	USACE	7	0.37	0.00	1.00	1.00	1.00
8	Alfalfa	USACE	8	0.37	0.00	1.00	1.00	1.00
9	Alfalfa	USACE	9	0.37	0.00	1.00	1.00	1.00
10	Alfalfa	USACE	10	0.37	0.00	1.00	1.00	1.00
11	Alfalfa	USACE	11	0.37	0.00	1.00	1.00	1.00
12	Alfalfa	USACE	12	0.37	0.00	1.00	1.00	1.00
13	Alfalfa	USACE	13	0.37	0.00	1.00	1.00	1.00
14	Alfalfa	USACE	14	0.37	0.00	1.00	1.00	1.00
15	Alfalfa	USACE	15	0.37	0.00	1.00	1.00	1.00
16	Alfalfa	USACE	16	0.37	0.00	1.00	1.00	1.00
17	Alfalfa	USACE	17	0.37	0.00	1.00	1.00	1.00
18	Alfalfa	USACE	18	0.37	0.00	1.00	1.00	1.00
19	Alfalfa	USACE	19	0.37	0.00	1.00	1.00	1.00
20	Alfalfa	USACE	20	0.37	0.00	1.00	1.00	1.00
21	Alfalfa	USACE	21	0.37	0.00	1.00	1.00	1.00
22	Alfalfa	USACE	22	0.37	0.00	1.00	1.00	1.00

Figure 3.94 Agriculture Products Damage Function

The final damage function viewer is for Vehicles. Figure 3.95 below shows the entry dialog for vehicles.



	VehicleType	VehicleId	Source	Description	VehicleHeight	Default
1	Car	Passenger Car	ABS Default	Damage to car from h	1.50	☑
2	LtTrk	Light Truck	ABS Default	Damage to light truck	2.70	☑
3	HvTrk	Heavy Truck	ABS Default	Damage to heavy truc	5.00	☑

Figure 3.95 Vehicle Damage Function

3.4.2 Viewing Restoration Functions

The flood model provides restoration functions for GBS and Essential Facilities. The GBS restoration functions are discussed in the *Analysis* menu, *Parameters* submenu discussion as the GBS values are included in the *Direct Economic* parameter tables. Built off the restoration timelines for the related GBS occupancies, the essential facilities restoration models provide the user with a general indication of the maximum restoration time for 100% operations. Obviously, there will be a great deal of effort to quickly restore essential facilities to full functionality and therefore this will be an indication of the maximum downtime.

The *Analysis* menu, *Restoration Functions* submenu opens the dialog seen in Figure 3.96 below. In this case, the figure shows the dialog on the Emergency Center Tab where the user can select Emergency Centers, Police Stations and Fire Stations. The restoration functions are editable and the user can adjust the "Max Days To Restoration" column and the "Functional Depth" column. These values are based on the depth of flooding at the specific facility (the latitude and longitude).

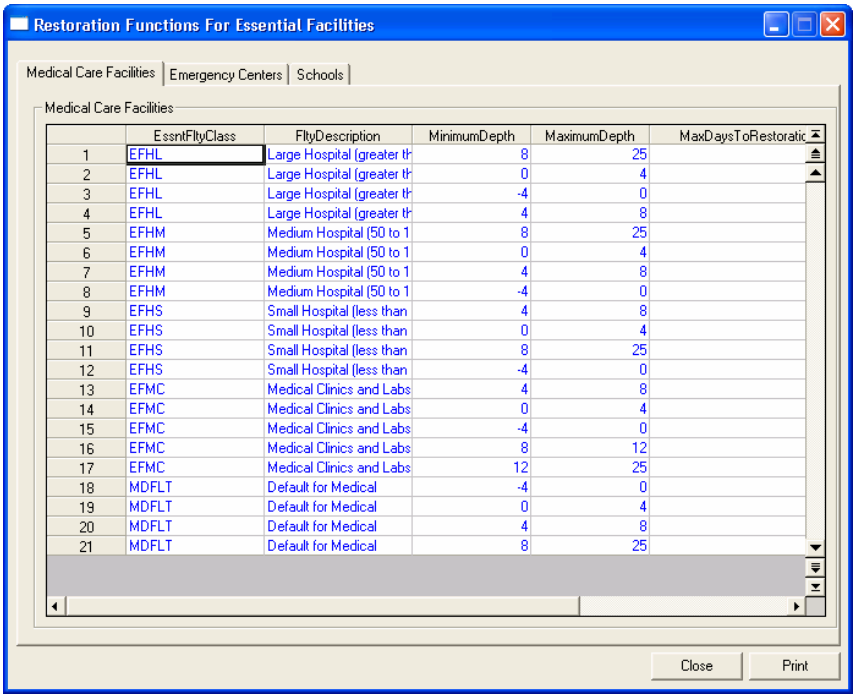

Restoration Functions For Essential Facilities
Medical Care Facilities
Emergency Centers
Schools
Medical Care Facilities
EssntFltyClass
FltyDescription
MinimumDepth
MaximumDepth
MaxDaysToRestoratic
1 EFHL Large Hospital (greater th 8 25
2 EFHL Large Hospital (greater th 0 4
3 EFHL Large Hospital (greater th -4 0
4 EFHL Large Hospital (greater th 4 8
5 EFHM Medium Hospital (50 to 1 8 25
6 EFHM Medium Hospital (50 to 1 0 4
7 EFHM Medium Hospital (50 to 1 4 8
8 EFHM Medium Hospital (50 to 1 -4 0
9 EFHS Small Hospital (less than 4 8
10 EFHS Small Hospital (less than 0 4
11 EFHS Small Hospital (less than 8 25
12 EFHS Small Hospital (less than -4 0
13 EFMC Medical Clinics and Labs 4 8
14 EFMC Medical Clinics and Labs 0 4
15 EFMC Medical Clinics and Labs -4 0
16 EFMC Medical Clinics and Labs 8 12
17 EFMC Medical Clinics and Labs 12 25
18 MDFLT Default for Medical -4 0
19 MDFLT Default for Medical 0 4
20 MDFLT Default for Medical 4 8
21 MDFLT Default for Medical 8 25
Close
Print

Figure 3.96 Essential Facilities Restoration Functions

3.4.3 Setting Analysis Parameters

There are several parameters that the user may want to view and/or modify prior to starting their analysis. In one case, Agriculture, the user is required to input a value before the flood model can perform the analysis. This section will walk the user through the parameters available to the user. Every attempt has been made to provide default values wherever possible and this allows the model to perform most requested analysis without user intervention.

The Analysis menu Parameters submenu appears in Figure 3.97 below. The menu provides access to the default parameters used in the analysis of *Debris*, *Shelter*, *Agriculture*, *Direct Economic*, and *Indirect Economic*. The Casualties menu item opens a word document that provides the user with some guidance on the natural average for casualties. The flood model does not provide estimates for flood related casualties at this time.

Figure 3.97 Analysis Parameters Menu

Selection of the Debris menu item opens an editable dialog that allows the user to view the default debris values. Debris is estimated based on the depth of flooding within the structure, similar to the estimation of GBS damage, specific occupancy, and whether the foundation has a footing or a slab. The user can use the combo boxes to shift between specific occupancies and the foundation types.

Debris is estimated in three main classifications that align loosely with the earthquake models method of classification including: finishes (dry wall, flooring, insulation, etc,), structure (framing, walls, exterior cladding), and foundation weight (concrete slab, concrete block or other foundation). Unlike the earthquake model, where moderate damage may still result in the foundation being removed, flooding requires the structure to be considered substantially damaged before the foundation is removed.

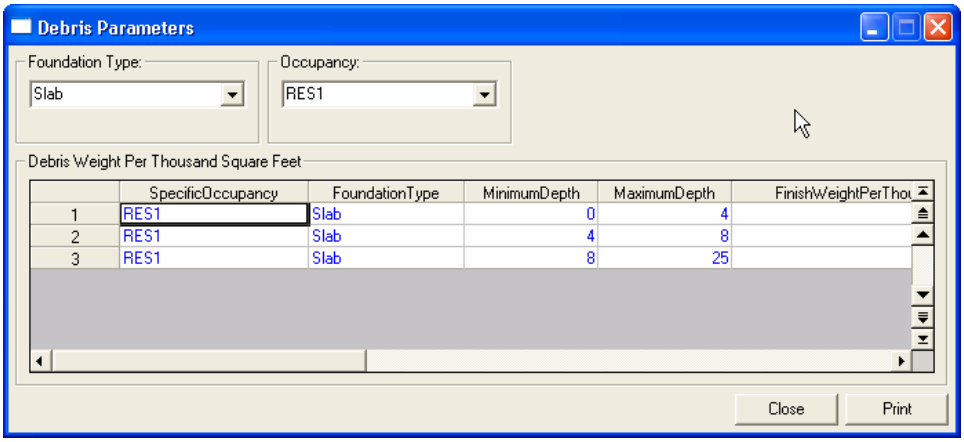


Figure 3.98 Debris Analysis Parameters

The *Shelter* menu item opens a dialog with multiple tabs and allows the user to gain access to the various parameters that affect the number of people who are evacuated (displaced) and the number of people who require short term sheltering. Since the flood model does not address flooding such as flash flooding or long-duration flooding at this time, there is an assumption that the local authorities will have time to alert the residents and evacuate directly from the areas that will flood. This means any portion of a census block that is flooded initially is assumed to have all of the residents removed from the area. Ultimately, the level of damage within the GBS will determine how many people require short-term sheltering.

The first tab (Figure 3.99) of the shelter parameter dialog allows the user to identify at what flood depth people are no longer allowed into or out of the flooded area. This input will not impact the results, but is provided to allow the user to think about their local plans and what access controls might be in place. The next input, the evacuation buffer, will have a direct impact on the results. This value is a buffer the flood model will add to the current floodplain polygon. In essence, this value will increase the floodplain polygon by the distance input by the user, such as 500-feet. The model will then estimate the total population within the floodplain boundary and the buffer to identify the displaced population.

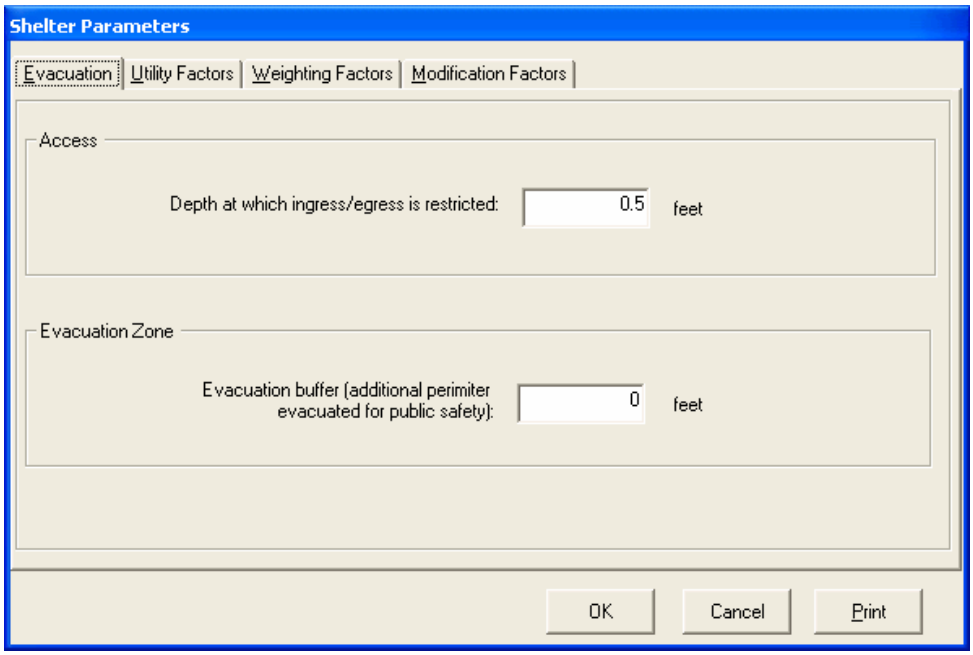


Figure 3.99 Shelter Evacuation Parameter

The Utility Outage tab is used in the determination of the short-term shelter needs. The lack of utilities to areas impacted by floodwaters will prevent some of the displaced population from

immediately returning to their homes. This percentage factored in as the short-term needs is developed.

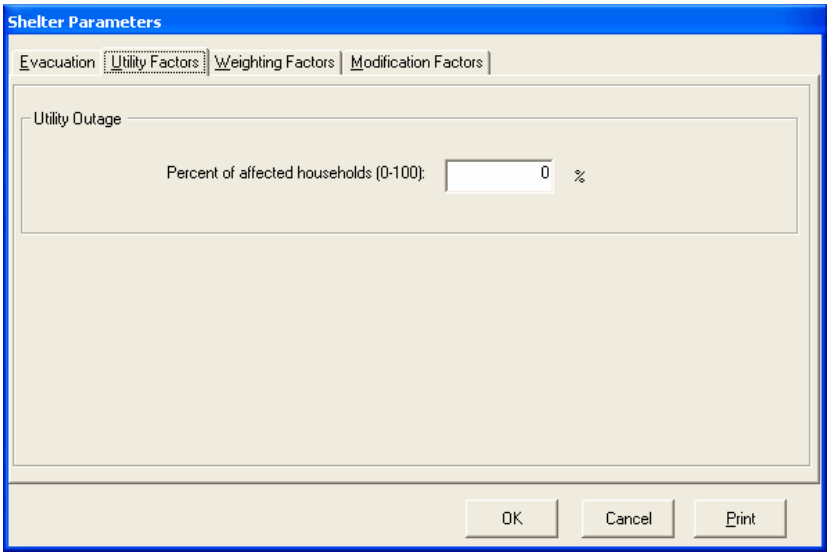


Figure 3.100 Shelter Utility Outage Parameter

The Weighting Factors tab is a table where the user can modify the weighting applied to certain demographic characteristics for the population. As seen in Figure 3.101 below, this includes income, age, ethnicity, and home ownership. Initially developed for the earthquake model, the weighting parameters do not have the same values and have much less emphasis on factors such as ethnicity (where the decision to seek shelter in earthquakes does vary with ethnicity) and ownership. As parameters, the fact that authorities evacuate most every resident and the population is not concerned about the structural integrity of the shelter site greatly reduces their importance. Age and Income carries about the same weighting as the earthquake model because these do tend to drive the decision to seek housing in a shelter site or an alternative location such as a hotel.

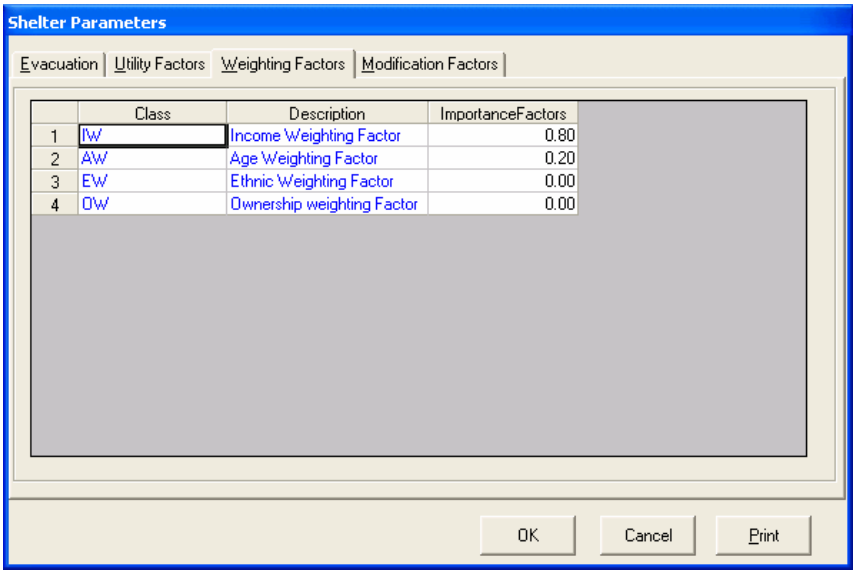


Figure 3.101 Shelter Weighting Factors

The Modification Factors tab could be considered more correctly the weighting factors sub classification weighting. For example, Figure 3.102 shows the Age modification factors. These factors allow the user to place more emphasis or increase the importance of the population under 16 thereby increasing the number of people under the age of 16-years who would seek shelters. The combo box provides the user access to the Income weighting also. Like the age factor, this allows the user to place more importance on those residents that fall within a certain income range.

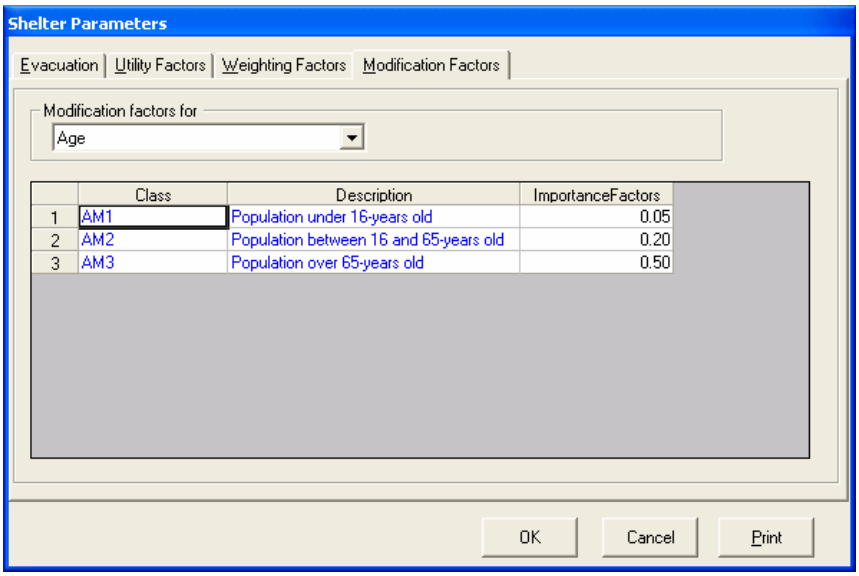


Figure 3.102 Shelter Modification Factors

Probably most important among the analysis parameters because no default value can be provided, the *Agriculture* menu item requires some user input in order for the agriculture analysis to run properly. Agriculture products are very dependent on the date when the flooding occurs. For example, if the flood occurs during the winter, and the type of crops grown in the region are typically planted in the spring, the net loss to the region will be pretty small. If, however, the flooding occurs just prior to harvest, when the farmers are the most heavily invested and their opportunity to replant the smallest, then the impacts and losses will be greater.

As stated previously, the flood model can determine the Julian date depending on the date the user inputs to the flood model. Figure 3.103 shows the dialog where the user provides a calendar date. The combo boxes allow the user to quickly select the day (01-31) and month (Jan.-Dec.) for conversion into Julian date (1-365).

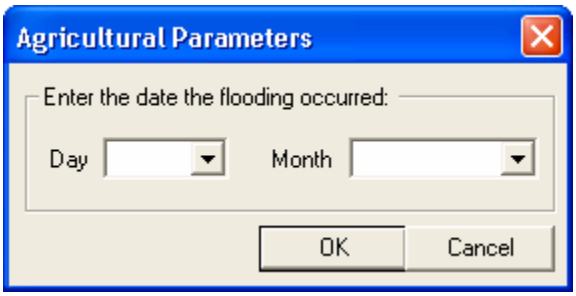


Figure 3.103 Agriculture Calendar Date Parameter

The *Direct Economic* parameter menu item opens the dialogs seen in Figure 3.104 through Figure 3.106. These dialogs provide the user with access to the default parameters that control the estimation of the direct damages to the general building stock. This includes the impact of the flood scenario on the wages, income, inventory and the maximum restoration time for the general building stock.

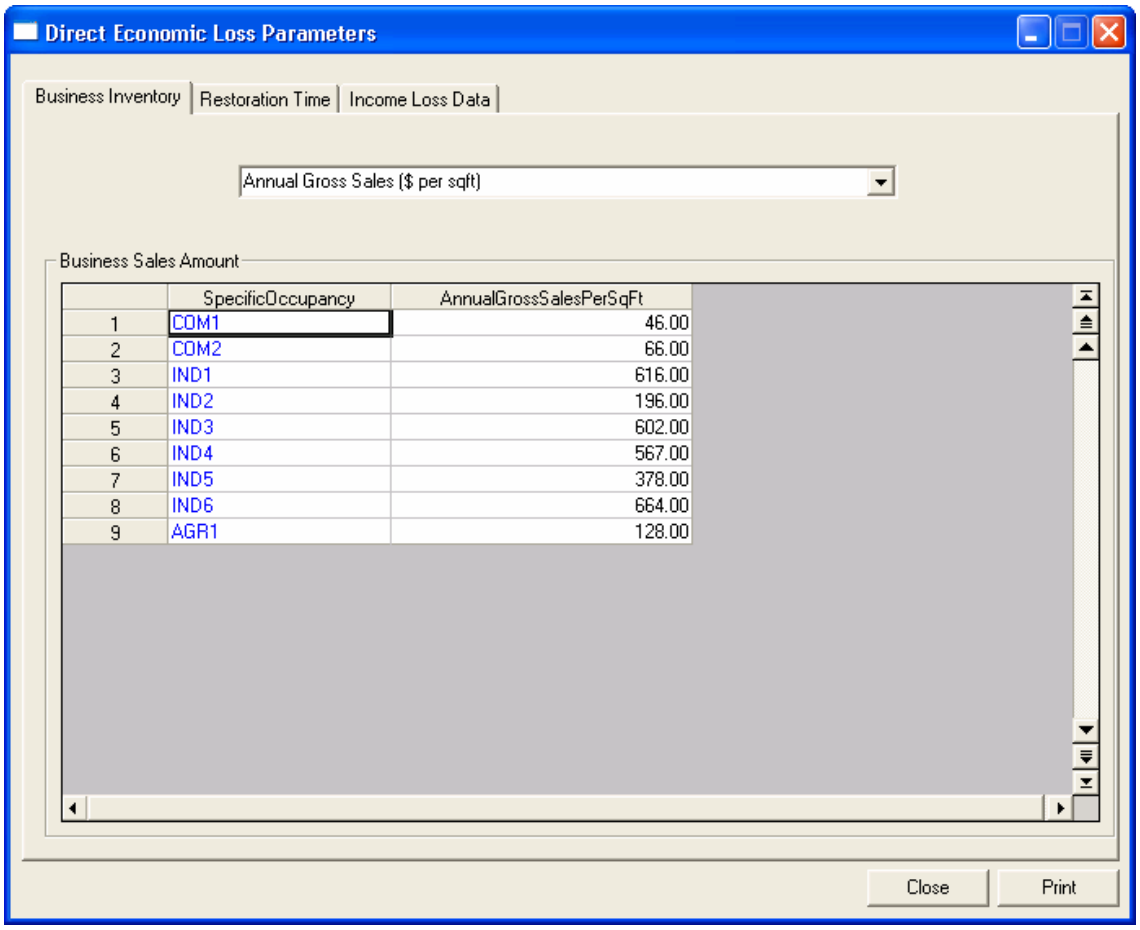


Figure 3.104 Direct Economic Parameter – Business Inventory

The GBS restoration functions define the maximum amount of time it should take for any given specific occupancy to be restored. For example, in Figure 3.105 the RES1 restoration time is based on the depth of flooding within the structure. In the case of the RES1, it is can be seen that even though the water has not fully entered the structure, it may take up to a year to clean up the structure, replace any sub-flooring that may be damaged, obtain permits, and inspections. Again, this is a maximum timeline meant to provide a conservative estimate for the losses associated with the restoration process.

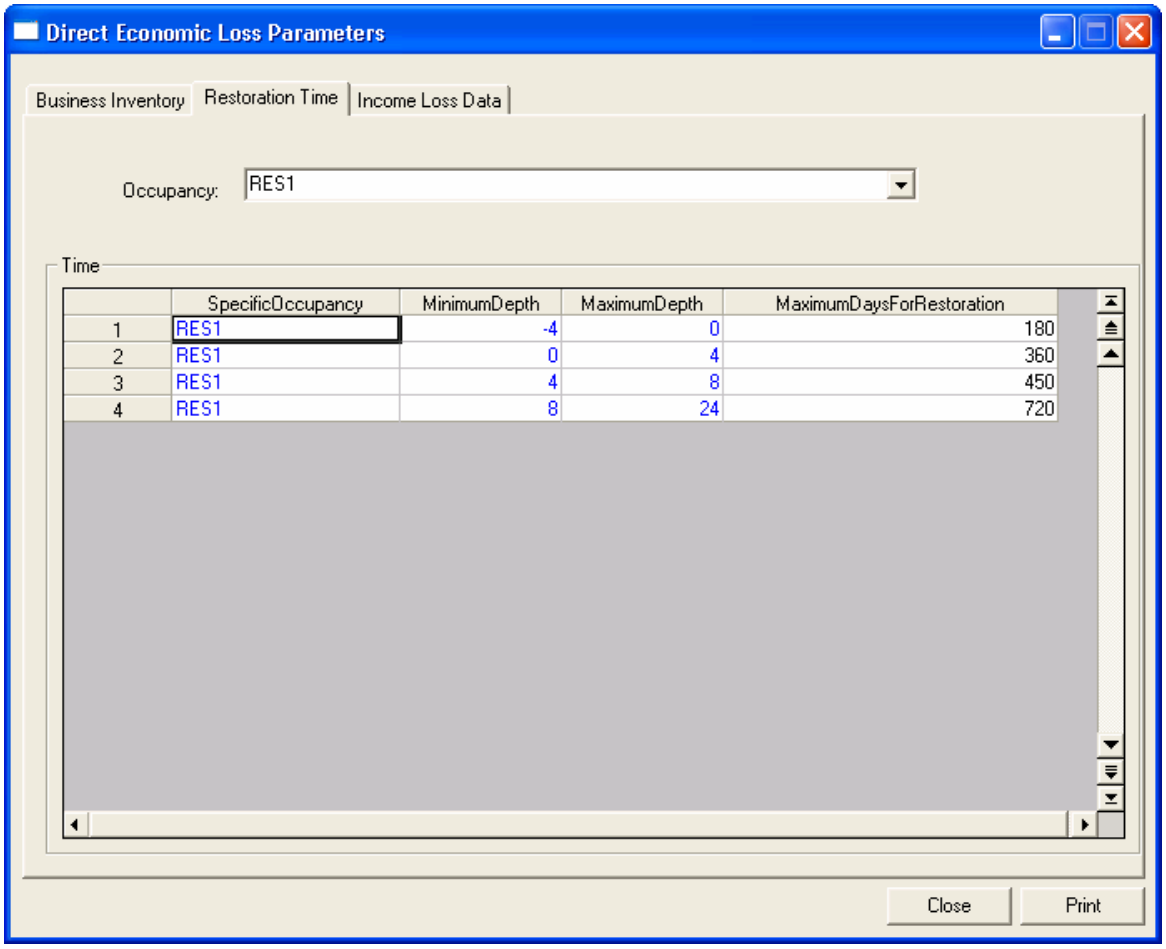


Figure 3.105 General Building Stock Maximum Restoration Time

It is important to note that some of the factors shown on the Direct Economic dialogs also feed into the Indirect Economic Loss Module. One example of can be viewed by the user through the selection of the Wages and Capital Related Income parameters found in the combo box at the top of the dialog in Figure 3.106 below. Parameters from these tables are used to identify IELM needs such as the total employees within the study region.

These parameters are also used to develop the direct losses for wages and capital income presented in the GBS Economic Losses.

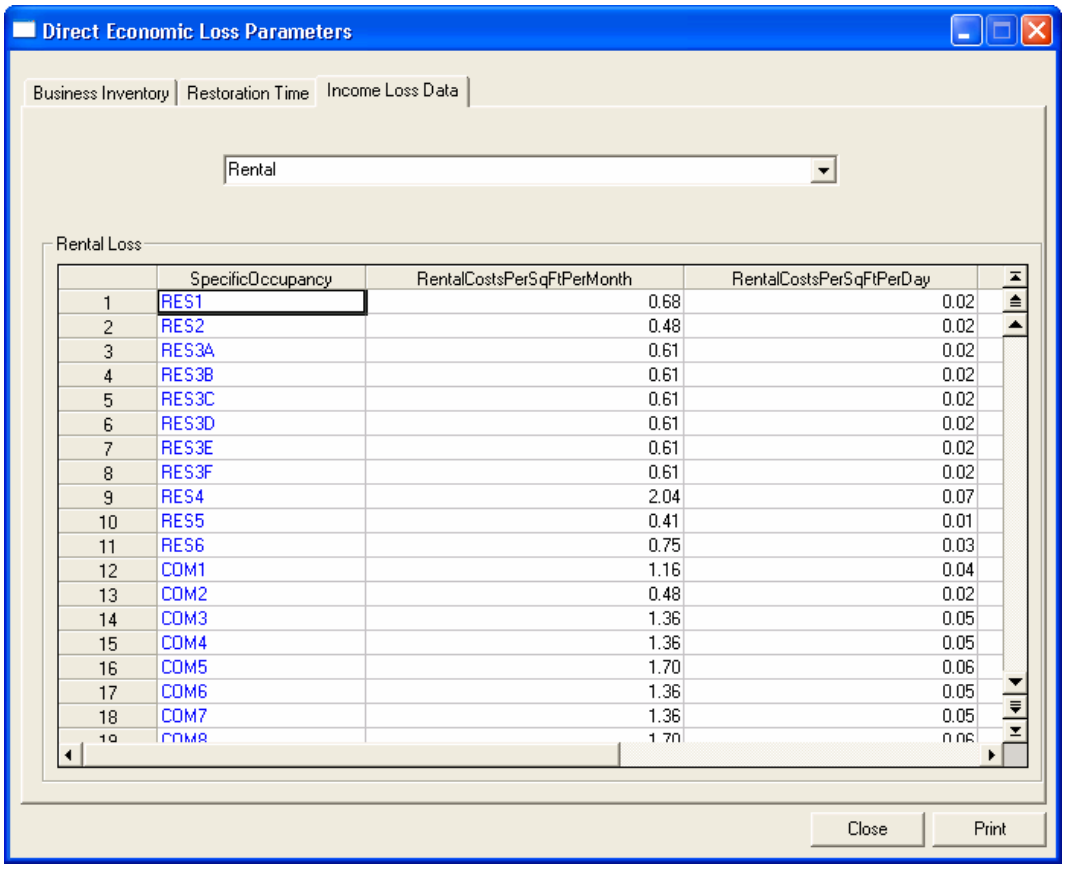


Figure 3.106 Income Loss Data – Rental, Owner Occupied, Wages and Capital, and Recapture Factors

3.4.4 Flood Warning

Another key parameter the user can use to perform "what-if" type analysis efforts is the Flood Warning. Flood warning is an interesting issue in that everyone assumes that damage and losses can be reduced with effective flood warning, but there is considerable disagreement over the amount of reduction, or even if it is possible to reduce damages based on effective warning. The Flood Model takes advantage of the famous Day curve developed by the USACE. This curve attempts to quantify the maximum level of damage reduction achievable based on the amount of time a flood warning has been available. The curve itself approaches a maximum value of

approximately 35% for structural, content, and business inventory losses regardless of how much warning is available.

Instead of having the user input a warning time and interpreting the Day curve to provide an expected reduction in damage, the flood model provides the Day curve in the Technical Manual and asks the user to estimate their warning time and find the expected reduction in damage, putting this factor into the dialog seen in Figure 3.107 below. The flood model will then uniformly reduce the damage by the anticipated reduction. In the case of vehicles, there was no evidence of documentation that provides any guidance on how much vehicular damage can be avoided with warning. Conventional wisdom would indicate that the percentage should be relatively high. With little information to work from, the flood model has provided the user to opportunity to select their vehicular reductions.

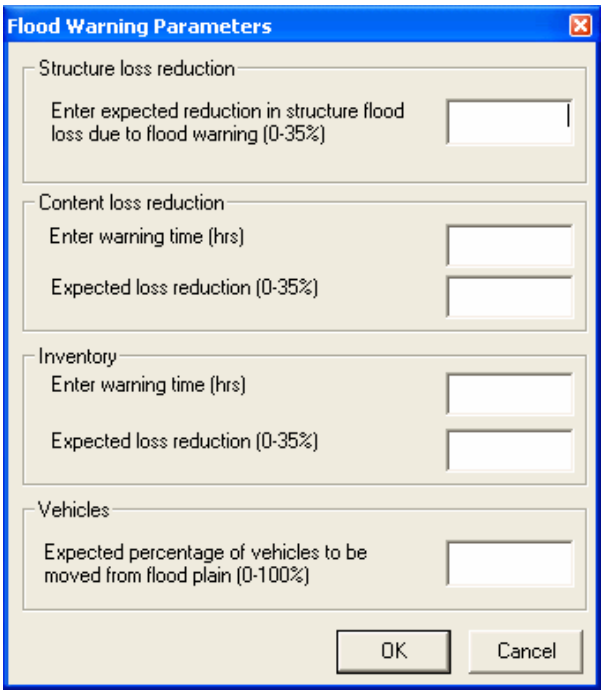

Flood Warning Parameters
Structure loss reduction
Enter expected reduction in structure flood loss due to flood warning (0-35%)
Content loss reduction
Enter warning time (hrs)
Expected loss reduction (0-35%)
Inventory
Enter warning time (hrs)
Expected loss reduction (0-35%)
Vehicles
Expected percentage of vehicles to be moved from flood plain (0-100%)
OK
Cancel

Figure 3.107 Warning Parameters

Note that the parameters for structures, contents, and business inventory are limited to a maximum of 35% based on the maximum provide by the Day curves. The user could input 100% reduction for vehicular damage and this may not be unreasonable if an area is evacuated with plenty of warning time. Note that the flood model has provided the user the option to input the warning time to help them remember the parameters that led to a particular value input into the dialog.

3.4.5 Annualized Loss

Annualized loss is a process by which the user can determine their maximum potential annual loss. This analysis requires that the user has performed an Annualized Loss on the Calculate hazard menus for Riverine, coastal or both as shown in the Figure 3.108 below.

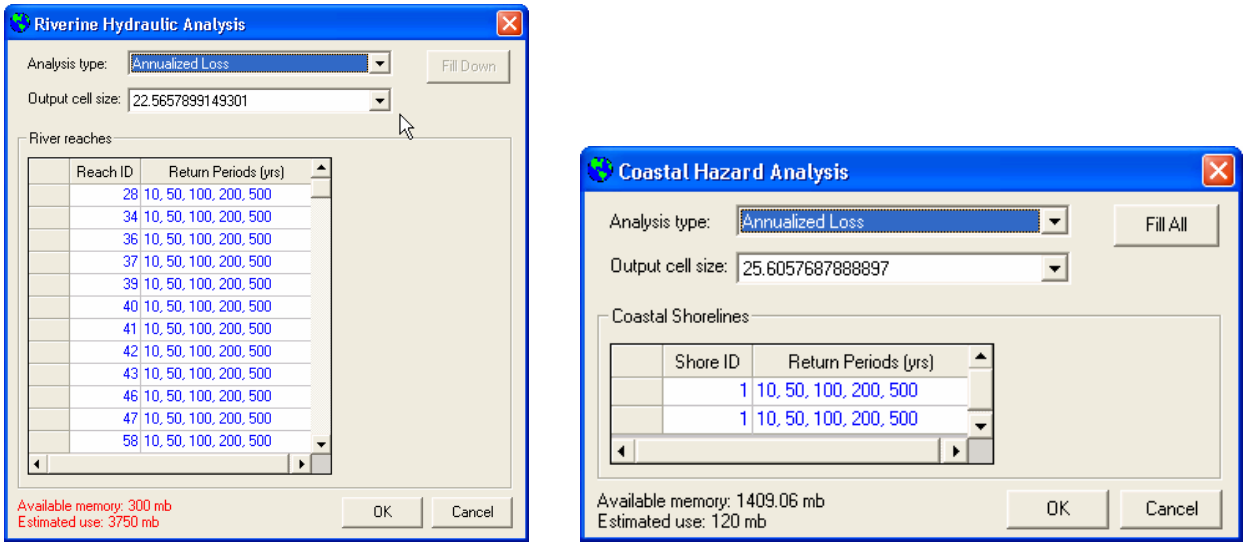


Figure 3.108 Hazard Analysis – Annualized Loss Selection

In order to perform an annualized loss assessment, the user must perform the following steps. 1) Select Annualized Loss on the *Delineate Floodplain* submenu. 2) Complete general building stock analysis from the *Run* selection on the *Analysis* menu. 3) Select *Annualized Loss* on the Analysis Menu. The first step ensures that all of the flood depth grids necessary to perform an annualized loss (10-, 50-, 100-, 200-, and 500-year) are available. The second step creates the analysis results from the return periods analyzed. The third step sets the analysis bits that tell the flood model to interpolate and extrapolate for other return periods and develop a maximum probably annual loss.

With the hazard developed for all of the necessary return periods, selection of the *Annualized Loss* menu item will set a flag that starts the analysis. Annualized losses are essentially the summation of losses over all return periods multiplied by the probability of those floods occurring. In mathematical terms, the analysis essentially looks like this:

$$AL = \Sigma \text{ (Prob of Occurrence)} * (\$ \text{ loss})$$

Naturally, the more losses you assess, the more accurate your answer will become. Because all three models within **HAZUS** need to produce common intervals to allow for the multi-hazard analysis, the flood model interpolates for some return intervals and extrapolates to others in

alignment with the earthquake and wind models. The user can view the results of the analysis in the Results browsers and Crystal Summary Reports.

3.4.6 Quick Look and Enhanced Quick Look

The Quick Look and Enhanced Quick Look was created to provide a user a way of performing a very quick "snapshot" type analysis to gain some insight into a particular problem. The Quick Analysis is intended to be used on vary localized flooding issues, and is intended to allow the user to establish some known condition and attempt to provide a quick quantification of potential loss.

An example of how the Quick Analysis might be used is if there are heavy rains in a community and there is one basin within the community where water typically collects. It has been several years and development has been allowed to occur in the area, which is outside of any regulatory floodplain. In Quick Look, the user can quickly draw a few polygons, assigning a depth of flooding to each in accordance with the recollections of the local population. In Enhanced Quick Look, the user can import a floodplain boundary polygon along with the DEM. The user would then perform a loss analysis to identify potential loss for either Quick Look or Enhanced Quick Look.

The quick analysis results can be viewed in the GBS browsers and the Quick Analysis Crystal Reports.

3.4.7 Running an Analysis

Once the user parameters have been selected or modified, select *Run* from the *Analysis* menu. The window shown in Figure 3.109 will pop up.

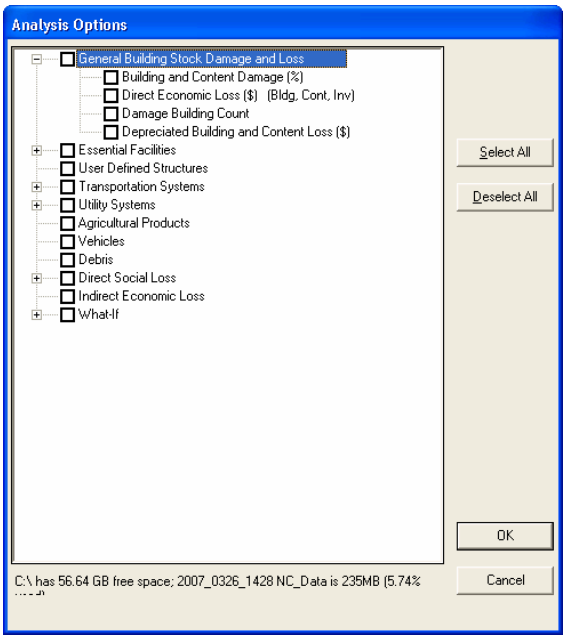


Figure 3.109 Selecting Analysis Options

Clicking on the plus and minus signs will expand and collapse the lists of available options. Click on the boxes of the analysis options you are interested in running, which will be marked with a check mark to indicate they are selected. Note that some analysis options have pre-requisite analysis requirements and selection of that option will automatically check the box of the prerequisite. At the bottom of the window, HAZUS will indicate the amount of hard drive disk space available on the machine and the percentage of the study region's database that has been used so far. The study region's database has a limit of 4 GB, therefore, if the percentage used is more than 50 percent, there is less than 2 GB of space that can be used for the analysis.

HAZUS can conduct default analysis runs for the following items:

- General building stock
- Essential facilities
- Selected infrastructure, including highway bridges and water systems
- Agriculture products,
- Vehicles,

- Debris,
- Shelter requirements

The types of default data provided for your study region limit the analysis modules that you can run. In order to run a What-If analysis, the same analysis must have been run from the hazard menu. When you have selected the desired analysis options, click *OK*.

When running the Analysis, the HAZUS screen might go blank or the Task Manager "Applications" tab will indicate that HAZUS is not responding. This is a common symptom for any software that is process heavy. In order to check if HAZUS is still running, users should check the Task Manager "Processes" tab and sort the "CPU" column in descending order. The "sqlservr.exe" process should be on top. If the "System Idle Process" is constantly on top at 99-100%, this could be an indication that HAZUS is not responding. Users could also check the "Performances" tab and make sure the CPU Usage is not zero (0) over a period of time. Another option is to open the scenario folder (in "Details" view) and make sure the FlAnalysisLog is updating by looking at the "Date modified."

Running the Analysis, specifically the General Building Stock Damage and Loss, can take up many hours to process and successfully complete.

For users who would like to view the intermediate analysis completion status, go to Tools/Flood Options, and check the "Show redo analyses warning message box(es)" checkbox (example shown in Figure 3.110). This option only applies if the user is redoing the analyses.

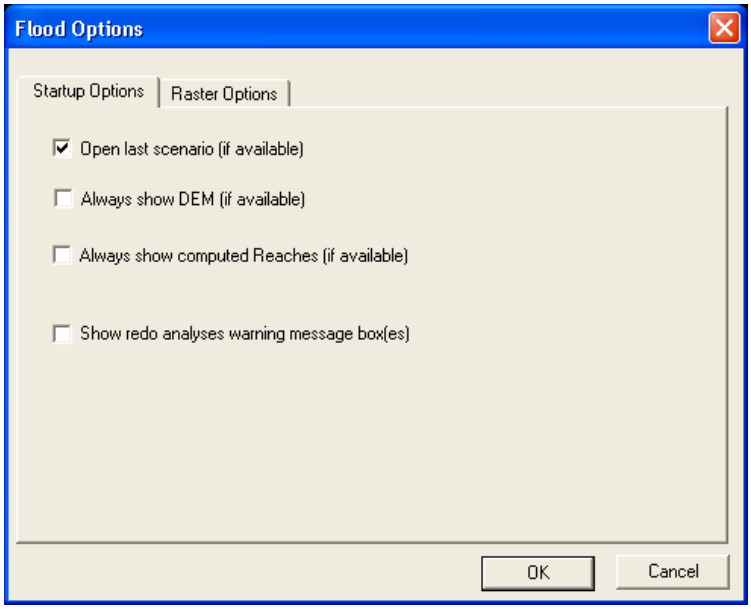


Figure 3.110 Flood Options

3.5 Viewing Analysis Results

Analysis results can be viewed in tabular, map or printed report formats. Before viewing results, you need to specify which scenario results you would like to open. Through this selection process, the user identifies which Scenario, Return Period, and Analysis Options.

3.5.1 Selecting a Case Study to View Results

Select *View Current Scenario Results By* from the *Results* menu. The window shown in Figure 3.111 will appear. You must select one of the available hazard analyses before you can review results in any form.

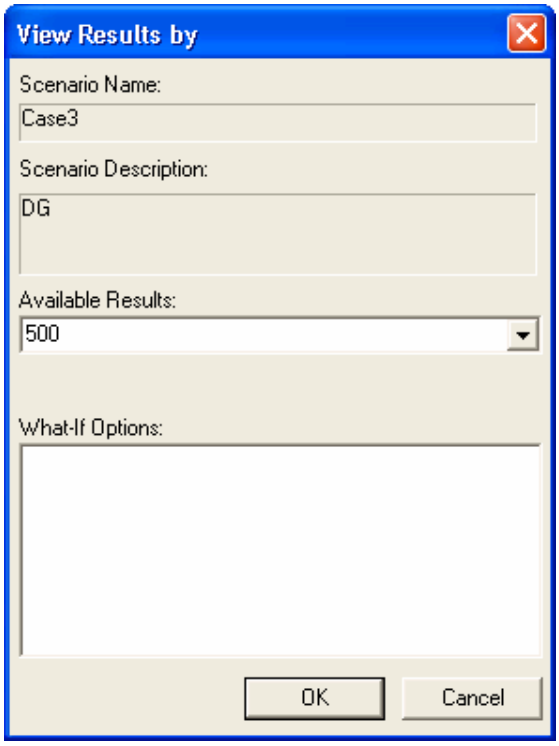


Figure 3.111 Selecting Available Results to View

3.5.2 View Tabular Results

We will view general building stock results as an example of viewing results in tabular form. From the *Results* menu and the *General Building Stock Damage* submenu, select *By Occupancy*. Results similar to those shown in Figure 3.112 will be shown.

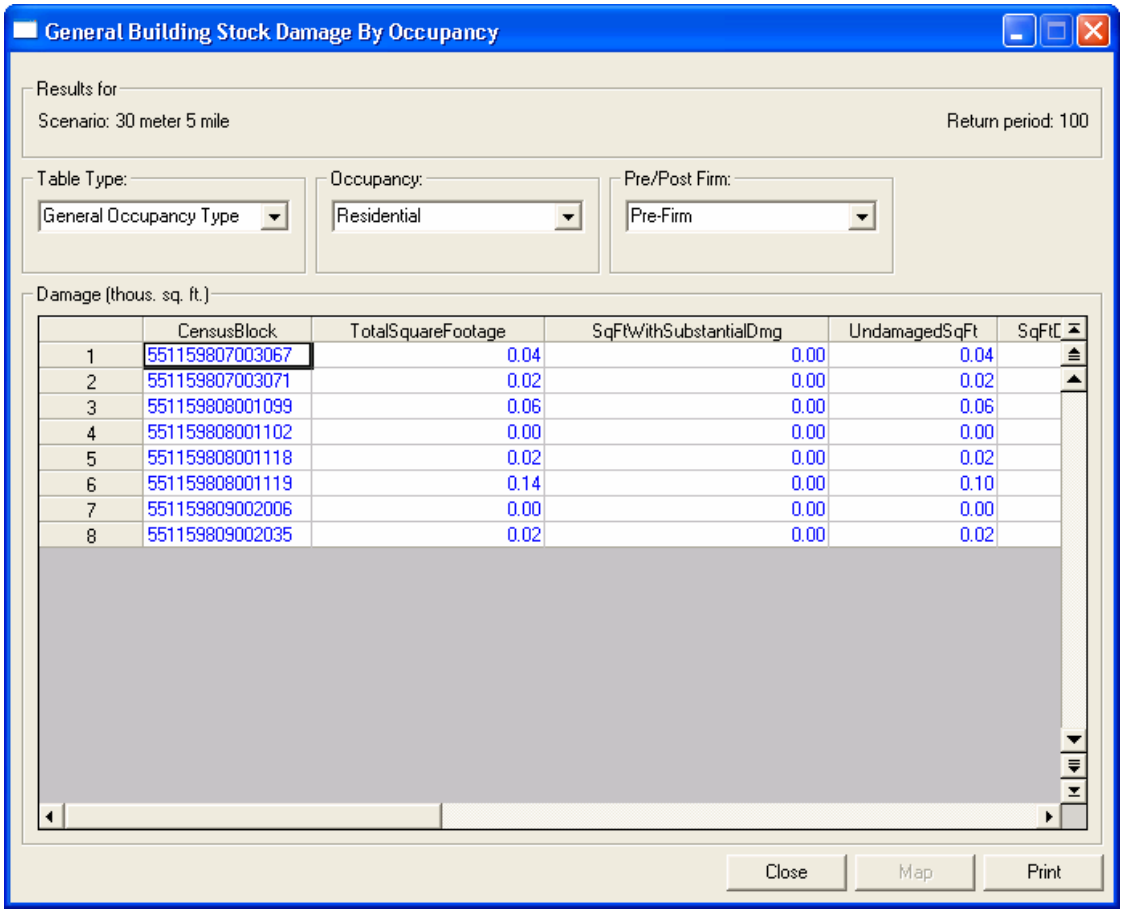


Figure 3.112 General Building Stock Damage by General Occupancy Table

General building stock damage results can also be displayed by building type and building count.

3.5.3 View Mapped Results

You can view mapped results of both the flood hazard and the resultant damage. To see the flood hazard mapped, select *Results/Flood Hazard Maps/Thematic Map of Depth*. The depth grid is shown in blue, with the floodplain boundary on top in orange.

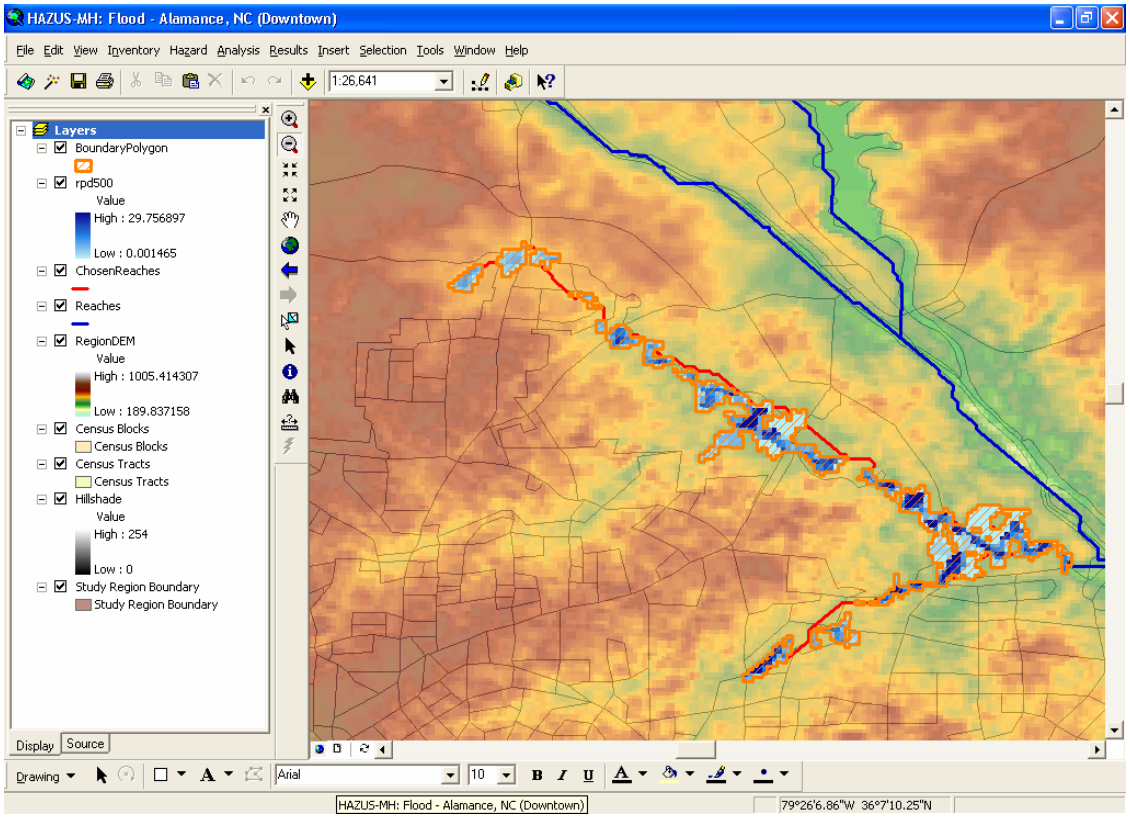


Figure 3.113 Thematic Depth Grid Map

To map the damage, first, view the results of interest in table form. The procedure to map results is the same as that to map inventory data, illustrated in section 3.2.1. Select the column of results that you like to map. Click on the *Map* button at the bottom of the window showing tabular results. Mapped results should appear on the screen.

3.5.4 Other Results

The results menu contains items to view many other results through tables and thematic maps. To avoid repetition, each menu item will not be discussed herein. Results will be available for those analysis modules checked in the Analysis/Run dialog.

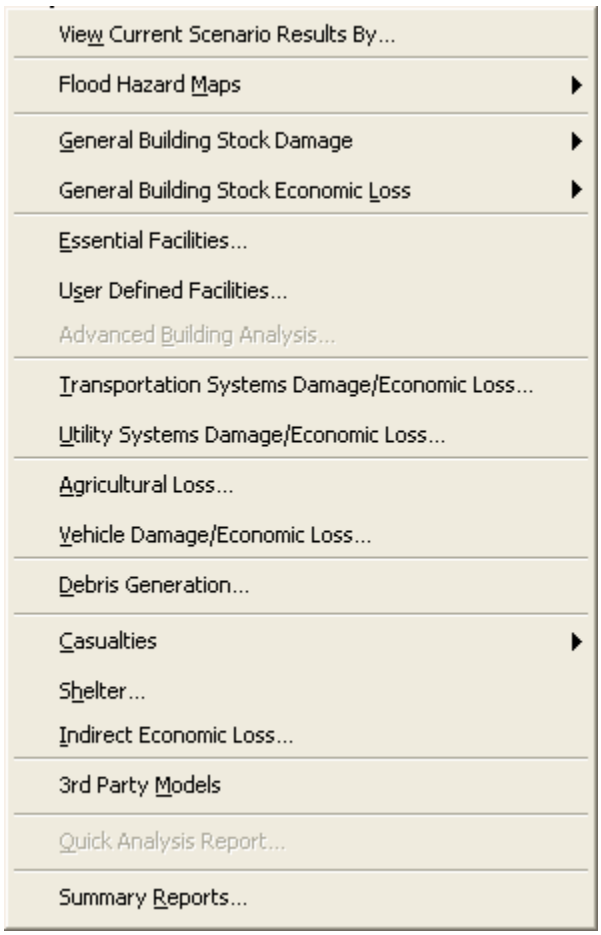


Figure 3.114 Results Menu

3.5.5 Print Reports

You can print results directly in table or map forms, or you can select one of the numerous pre-formatted reports built-in to **HAZUS**. To access these pre-formatted reports, select *Summary Reports* from the *Results* menu (Figure 3.115). The flood model provides 40 such reports in categories of inventory exposure, building damage, lifeline damage, induced, losses, and other.

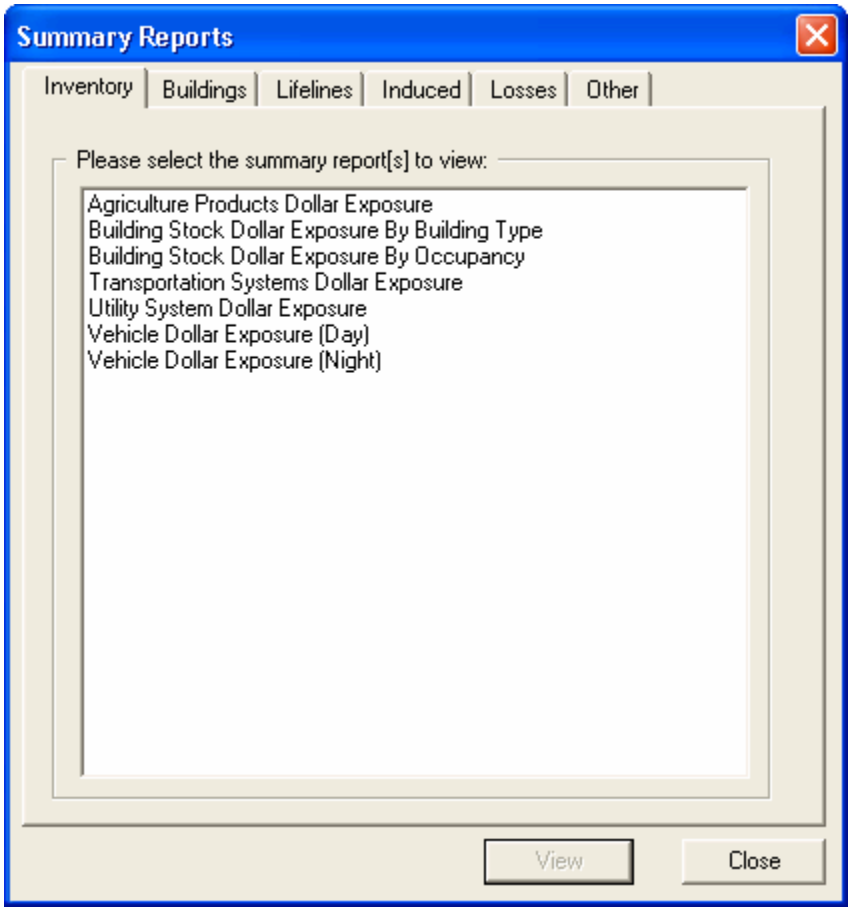


Figure 3.115 Summary Reports Dialog

To display a report, select the report of interest and click on the **View** button (Figure 3.116).

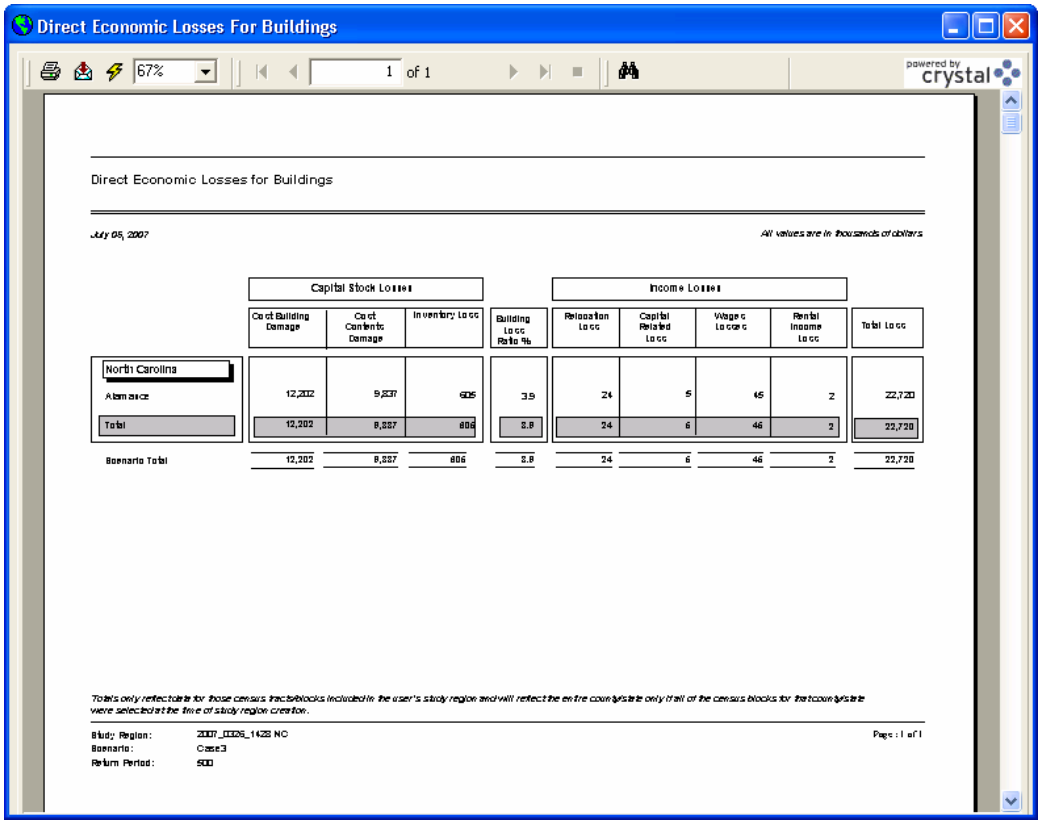


Figure 3.116 Sample Summary Report

To print the report, click on the print button in the upper left hand corner of the report window. In addition, the summary report can be exported to a number of file formats by clicking on the export button in the upper left hand corner of the report window.

3.6 Default Databases

The loss estimates produced are crude estimates of losses based on a minimum of local input. Most users will develop a local inventory that best reflects the characteristics of their region, such as building types and demographics. The quality and uncertainty of the results are affected by the detail and accuracy of the community-specific data provided. Estimates produced using default data, as done in this Section, should only be used as initial estimates to determine where more detailed data collection and analyses are warranted, or for studies covering large geographic areas.

This section describes the types of data that are supplied as defaults with **HAZUS**. Default inventory databases are of two types. The first type is a national listing of individual facilities, such as dams, bridges, or locations where hazardous materials are stored. These databases are modified versions of publicly available databases. The modifications that have been made have been to eliminate data elements that are not needed for natural disaster loss estimations. The second type of default database consists of data aggregated on a county, census tract or census

block level. Examples are building stock square footage for each census block. These default databases are also derived from publicly available data.

The default databases are stored on the **HAZUS** DVD. When you create a study region, **HAZUS** extracts only those portions of the databases that are relevant to your study region and your selected hazards, and stores them on your computer's hard drive. You can then access these region specific default databases and update them with improved information that you have obtained, as discussed in Section 7.

A list of default inventory information currently supplied with **HAZUS** appears in Table 4.1 in the next Section.

In addition to default databases, the user is supplied with default analysis parameters documented throughout the Technical Manual. In many cases these parameters are defined on a national basis without adjustments for regional variations. In other cases such as with percent of buildings with basements, regional variations are included. Examples of default parameters are costs per square foot to replace a structure of a certain specific occupancy class and estimated height of the first floor above grade for various foundation types. Depth-damage curves are supplied for each specific occupancy class. The user can modify all of these parameters if better information is available, as discussed in Sections 7 and 10.

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Chapter 4 Data Needed for a More Complete Loss Estimation Study

To estimate losses due to natural disasters, you need to characterize both the potential hazard and the environment that will be impacted. Clearly, a flood that occurs near a densely populated region will cause different types of losses than one that occurs in a mostly agricultural region. The **HAZUS** software comes with default data about the buildings, utilities and people that occupy an area, and the hydrologic and hydraulic characteristics of flooding events. These defaults provide good starting points for flood risk analyses, but many users will want to collect better data on their community's inventory and hazard characteristics.

This section describes the approach you should take for developing more detailed data sets on the structures, people and characteristics that contribute to your community's flood risk. Compiling a community inventory is discussed, followed by a discussion of improving flood hazard data. For ideas about potential sources for this information, see Section 5.

4.1 Developing an Inventory

The inventory data analyzed by **HAZUS** includes the general building stock, essential facilities, high potential loss facilities, transportation systems, utility systems, facilities storing hazardous materials, demographics, agricultural products, vehicles, and user-defined facilities. First, you need to identify the elements of the inventory that are most critical for the analyses you wish to run. For example, if you are most interested in potential economic losses in residential structures, your data collection efforts should focus on collecting data on the number of residential buildings, their characteristics, and values. Second, design an approach for collecting the data. Some data can be found in pre-existing computer databases; others will have to be compiled into databases for the first time. All data collection and compilation efforts need to be done using the classification schemes required by **HAZUS-MH**, introduced below and discussed in more detail in the Technical Manual.

4.1.1 Inventory Components

Table 4.1 lists the inventory components that can be analyzed by **HAZUS-MH**. Each user should identify those items that are most important to their communities. Some of these items have default data provided with the **HAZUS** software, as indicated. While **HAZUS** allows users to input data on all of these topics, the damage and losses are only calculated for specific types of facilities, as indicated. Even though **HAZUS** does not calculate detailed losses for military facilities, as an example, it can be useful to input detailed data about these facilities and view their locations and characteristics in the context of the calculated flood hazard.

Table 4.1 HAZUS Flood Inventory Components

TYPE OF INFRASTRUCTURE	INPUT DATA	DEFAULT DATA
General Building Stock	• Square footage by specific occupancy class	✓
	• Number of buildings by specific occupancy class	✓
	• Replacement cost per square foot by specific occupancy class	✓
	• Dollar exposure	✓
	• Depreciation parameters	✓
	• Foundation types and first floor heights by specific occupancy class	✓
Essential Facilities	• Medical care facilities	✓
	• Emergency operations centers	✓
	• Police stations	✓
	• Fire stations	✓
	• Schools	✓
High Potential Loss Facilities	• Dams and levees	✓
	• Nuclear facilities	
	• Military facilities	
Transportation Systems	• Highways infrastructure	✓
	• Railway infrastructure	
	• Airports	✓
	• Bus, port, light rail, and ferry infrastructure	
Utility Systems	• Potable water systems	✓
	• Wastewater infrastructure	
	• Oil and gas infrastructure	
	• Electric power infrastructure	
	• Communications infrastructure	
Hazardous Materials	• Specific locations and characteristics	✓
Demographics	• Population by age, race, and income levels	✓
	• Day and night populations	✓
	• Number of property owners and renters	✓
	• Rental and vacancy rates	✓
Agricultural Products	•	
Vehicles	• Vehicles by type and value	✓
	• Vehicles during day and night hours	✓
User defined facilities	• Any facilities which the user wishes to analyze on an individual basis	

For detailed information about the exact format of data to collect, please see the Technical Manual and examine the tables under the *Inventory* menu.

4.1.2 Approach

In developing a regional inventory, it is almost impossible from a cost point of view to individually identify and inventory each man-made structure. Some important structures such as hospitals, schools, emergency operation centers, fire stations, important bridges, and electrical power substations may be identified individually, but the majority of buildings in a region are grouped together collectively and identified by their total value or square footage. To permit modeling of spatial variation in types and occupancies of buildings, a region is built up from sub-regions, and the inventory is collected for each sub-region. In the flood loss estimation methodology, census blocks are used as the basic sub-region unit, and all regions are built up by aggregating data for individual census blocks. Thus for each census block, your inventory might consist of the number of square feet of buildings by specific occupancy type, the probability of a building having a specific foundation by specific occupancy type, and the average height of the first floor above grade by foundation type.

In the **HAZUS** loss estimation methodology, the residential, commercial, industrial and other buildings that are not identified individually are aggregated and in aggregate, are referred to as the General Building Stock (GBS). The General Building Stock is inventoried by calculating, for each census block, the total square footage of groups of buildings with specific characteristics (i.e., calculating the total square footage of all one story single family homes that have basements). While the default GBS data has been built from data in the U.S. Census, and from data on commercial enterprises provided by Dun & Bradstreet, replacing the default data with more precise data collected at the local level can be problematic. There are rarely reliable and complete databases that provide the necessary information such as building size, foundation type, height of the first floor, and value of contents that could be used to obtain total values for each census block or tract. Therefore, in general, inferences are made about large groups of buildings based on land use patterns, census information, business patterns, assessors' data, insurance information, etc. Similar types of inferences are made with respect to lifeline systems (e.g., the number of miles of water supply pipe in a census block may be inferred from the number of miles of streets).

In contrast to the inventory of General Building Stock, which is maintained in terms of total square footage or building counts per census block or tract, facilities that have some special significance such as essential facilities or components of lifeline systems can be maintained in the database by individual location. Within **HAZUS,** losses for essential facilities and some lifeline components are computed for individual facilities, whereas losses for the General Building Stock are calculated by census block or tract. While some inferences may be required to supplement available data for site-specific facilities when data are unavailable, these data are often more readily available than those required for the General Building Stock. Sometimes there will be few enough of these facilities that you can actually go to the site and collect the required inventory information. Sources of inventory information and how to go about collecting it are discussed in Section 5.

4.1.3 Classification Systems

There are two issues that must be considered in the development of an inventory: classification of data, and collection and handling of data. Classification systems are essential to ensuring a uniform interpretation of data and results. As discussed earlier, it is almost impossible, from a cost point of view, to identify and individually inventory each building or component of each lifeline. Thus losses in a regional study are estimated based on general characteristics of buildings or lifeline components, and classification systems are a tool to group together structures or lifeline components that would be expected to behave similarly in a flood event. For each of the types of data that must be collected to perform a loss study, a classification system has been defined in this methodology.

For example, the building classification system used in this methodology has been developed to provide the ability to differentiate between buildings with substantially different damage and loss characteristics. In general, the amount of damage sustained by buildings is different due to their precise location, the elevation of the first floor, the value of the structure and contents, and the building's configuration and exposure to flood waters. As a consequence of these variations, no two buildings will experience the same levels of damage when subjected to a flood. Therefore, occupancy classes and model building types are defined to represent the typical characteristics of buildings in a class. Within any given class there will be a great deal of variation.

To model flood losses within **HAZUS**, the most relevant classification for the General Building Stock is the occupancy classification scheme. The occupancy classification scheme is broken into general occupancy and specific occupancy classes. The general occupancy classification system consists of seven groups: residential, commercial, industrial, agriculture, religion/non-profit, government, and education. The specific occupancy classification scheme consists of 33 classes, shown in Table 4.2. Occupancy classes are used to account for the fact that contributions to losses are driven by both the structural characteristics and non-structural elements, and the types and costs of both structural and non-structural elements are often governed by the occupancy of the building, e.g., in a warehouse there may be few expensive wall coverings, whereas a bank may have expensive lighting and wall finishes. If these two buildings experience the same depths of flooding, the costs to repair the bank will be greater than the warehouse due to the more expensive finishes. Other issues related to occupancy may also be important, such as rental costs, number of employees, type of building contents and importance of function.

Table 4.2 HAZUS Specific Occupancy Classes

HAZUS-MH MR2 Label	Occupancy Class	HAZUS-MH MR2 Label	Occupancy Class
RES1	Single Family Dwelling	COM7	Medical Office/Clinic
RES2	Mobile Home	COM8	Entertainment & Recreation
RES3A	Multi Family Dwelling - Duplex	COM9	Theaters
RES3B	Multi Family Dwelling – 3-4 Units	COM10	Parking
RES3C	Multi Family Dwelling – 5-9 Units	IND1	Heavy
RES3D	Multi Family Dwelling – 10-19 Units	IND2	Light
RES3E	Multi Family Dwelling – 20-49 Units	IND3	Food/Drugs/Chemicals
RES3F	Multi Family Dwelling – 50+ Units	IND4	Metals/Minerals Processing
RES4	Temporary Lodging	IND5	High Technology
RES5	Institutional Dormitory	IND6	Construction
RES6	Nursing Home	AGR1	Agriculture
COM1	Retail Trade	REL1	Church/Membership Organizations
COM2	Wholesale Trade	GOV1	General Services
COM3	Personal and Repair Services	GOV2	Emergency Response
COM4	Business/Professional/Technical Services	EDU1	Schools/Libraries
COM5	Depository Institutions	EDU2	Colleges/Universities
COM6	Hospital		

For more detail about the **HAZUS** classification systems, please refer to the Technical Manual.

4.2 Improving Flood Hazard Data

Improving the quality of flood hazard information will make the analyses more accurate. Improved information could include superior ground elevation data, FIRM floodplain boundaries, or the output of detailed, local hydrologic analyses. The Flood Information Tool (FIT) has been developed to process user-supplied hazard data, in a wide variety of forms, into the formats required by the **HAZUS** model. A schematic of the FIT appears in Figure 4.1. The FIT has a separate manual, which users who plan to enhance their flood hazard data should consult. A brief overview of the capabilities of the FIT is presented below.

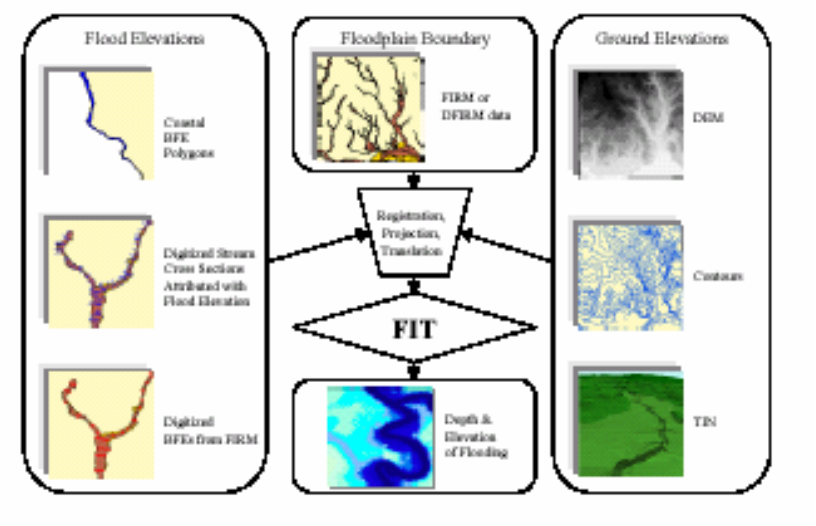


Figure 4.1 FIT Schematic

4.2.1 Riverine Capabilities

The riverine portion of the FIT was developed to allow users of **HAZUS** to incorporate results of their own, stream-specific, hydraulic models. The primary FIT output is a flood depth grid or a set of such grids formatted for use in **HAZUS**. The spatial data required to run the riverine portion of the FIT are a digital elevation model (DEM), a set of polylines (cross sections) attributed with flood elevations, and a polygon that defines a representative floodplain boundary. The DEM should be an ArcInfo grid; the polyline and polygon files should be ESRI feature classes.

4.2.2 Coastal Capabilities

The coastal portion of the FIT was developed to allow users of **HAZUS** to incorporate data from coastal flood hazard maps produced by FEMA or produced by other sources. The result of the FIT is a flood depth grid or a set of such grids formatted for use in **HAZUS.** The data required to run the coastal portion of the FIT are a digital elevation model (DEM), a set of polygons (areas subject to flooding) attributed with base flood elevations (BFE) and FEMA flood hazard zones (e.g., zone VE, zone AE, etc.) and a polygon representing the analysis boundary. The DEM is an ARCINFO grid; the polygon files are ESRI feature classes. The flood elevation polygons used by the coastal FIT must be associated with the base flood (100-year flood). They are used by the FIT to generate a 100-year flood elevation grid, and form the basis for all other return period flood surfaces calculated by the FIT.

Chapter 5 Updating HAZUS Inventory Data (Collecting Data)

A limiting factor in performing a loss estimation study is the cost and quality of the inventory. Collection of inventory is without question the most costly part of performing the study. Crude estimates of damage do not require extensive inventory data and can be performed on a modest budget. As the damage estimates become more precise, the need for better inventory information increases, as does the cost to obtain this information. Since many municipalities have limited budgets for performing a flood loss estimation study, **HAZUS** accommodates different users with different levels of resources. It should be understood, however, that the uncertainty of the loss estimates increases with less detailed inventory, and that there are uncertainties associated with modules other than inventory. For example, even with a perfectly accurate inventory of buildings in the study region, **HAZUS** or any other loss estimation methodology cannot infallibly predict damage and associated losses.

Inventory information will come from and/or be collected in databases compatible with the GIS technology. Once collected and entered into the database, the data will also be available to users for other applications. For example, data collected for a flood loss estimation study could also be used for city planning purposes.

5.1 Sources of Information

As discussed in Chapter 3, the use of default parameters and default inventory in performing a loss study introduces a great deal of uncertainty. Loss studies performed with only default data may be best for preliminary assessments to determine where more information is needed. For example, if the analysis using only default information suggests that hurricanes will cause a great deal of damage in a particular part of your community, you may want to collect more detailed inventory for that area to have a better understanding of the types of structures, the essential facilities and businesses that will be affected.

Regional building inventories can be built up from a variety of sources, including: federal government, state government, and local government and private sector databases. These databases may be useful for obtaining facility-specific information. Following are examples of sources of inventory data that can be accessed to enhance the **HAZUS** building data:

- Locations of government facilities such as military installations and government offices
- Tax assessor’s files
- School district or university system facilities
- Databases of fire stations or police stations
- Databases of historical buildings
- Databases of churches and other religious facilities

- Postal facilities (ATC-26, 1992)
- Hospitals (The AHA Guide of the American Hospital Association; ATC-23A, 1991)
- Public and private utility facility databases
- Department of transportation bridge inventory
- Dun and Bradstreet database of business establishments
- Insurance Services Office's files of large buildings that is used for fire assessment
- real estate databases

It should be kept in mind that each of these databases includes only a portion of the building stock, and none is complete. For example, the tax assessor's files do not include untaxed properties such as government buildings, public works and tax-exempt private properties. School district databases probably will not include private schools. A good discussion of available databases is found in ATC-13 (1985) and Vasudevan et al. (1992), although some of the databases discussed in these two references are specific to California.

Another possible source of inventory information is previous loss or hazard studies. Unfortunately many regional loss studies do not contain a listing (either hard copy or electronic) of the inventory that was used. The following sections contain more detailed information about sources of information for specific modules of the Flood Model.

5.1.1 General Building Stock

Developing the inventory for general building stock most likely will require combining information from several sources. As mentioned earlier, there is no complete single source of general building stock information. In addition, you will find that the quality and format of the information varies dramatically from county to county. Furthermore, since general building stock inventory is not normally compiled by counting individual buildings, but instead is developed using various assumptions and inferences, you may find that you need input from local engineers and building officials to ensure that you have captured unique aspects of the region.

5.1.1.1 County Tax Assessor Files

County Tax Assessor files may or may not be a source of general building stock information. Since Tax Assessor files are kept for the purposes of collecting property taxes, they may contain little or no useful structural information. The quality of the data varies widely from county to county. The most useful data will contain occupancy, structural type, square footage, height, and age. Generally, the files contain good information on the use (occupancy) of the building, since tax rates often depend on building use; therefore, either a land use code and/or a specific occupancy of the building is included. Ideally, if good information is available, you can use the Building Data Import Tool (BIT) described in Chapter 8 to develop region-specific occupancy to model building type relationships. However, several problems generally occur:

- Many Tax Assessor files do not contain building square footage information. In some counties, square footage is not recorded at all. In other cases, it is only sometimes recorded. You should ask the Tax Assessor before you buy the records as to what percentage of the records contain square footage information.

- Many Tax Assessor files contain square footage information that may be difficult to interpret. For example, a property that is owned by several owners (such as an office building) may appear several times in the files. Perhaps Owner #1 owns two floors of the building and Owner #2 owns eight floors. The Tax Assessor's records may not reflect the fact that Owner #1 owns 20% of the Building and Owner #2 owns 80%. In fact, sometimes both property entries will show the total building square footage instead of Owner #1 with 20% of the square footage and Owner #2 with 80%. Without going through the files record by record, this is difficult to fix.

- Since some occupants that do not pay taxes (e.g., schools, churches, and government buildings) are not usually well represented in the Tax Assessor's files. Often these types of properties include an entry and an Assessor's Parcel Number, but omit assessed value, square footage, structural type, height or age.

- Structural type may not be recorded at all in the files. You need to ask the Tax Assessor what percentage of the records has structural information before you buy the files.

- Similar comments about missing data can be made about age and height.

- Some or all of the properties in the Tax Assessor's files may contain no address information. In some counties, the Assessor's Parcel Number is the only identifier in the database. While this can be mapped to location, it is not an easy task. The file may contain a mailing address of the owner, but this is not a reliable address to locate properties. In other cases, selected properties are missing addresses. Address information is important because you can use addresses to see how the types and occupancies of buildings vary geographically.

- Perhaps one of the most difficult problems is that, in many cases, the Tax Assessors use a system of classifying structures that is difficult to map to the model building types defined in Appendix B. For example, there may only be five building types, such as steel frame, wood frame, fire resistant, masonry and other. It is difficult from this very simple classification system to determine whether masonry structures are reinforced or un-reinforced. Fire resistant construction could include a variety of structural types consisting of concrete or masonry. In these cases you will need to use local experts to help define the mix of construction.

5.1.1.2 Commercial Sources of Property Data

There are a variety of on-line services that maintain databases of real property that are designed to assist realtors and other commercial enterprises in gathering property sales data and owner information, and to assist in generating mailing lists and labels. The databases are developed from County Tax Assessor's files and updated as properties are sold or as other information

becomes available. You can subscribe to one of these services and download records over a telephone line, or you can order CDs of selected counties and use software supplied by the service to extract the records on your own computer. It seems that different services tend to focus their efforts in different parts of the United States. Therefore, one service may not maintain a database on the county you wish to study while another service may. Typical costs for a county are $300 to $1000, depending on its size. Addresses and phone numbers of several on-line services are listed below. (Note: While these are California addresses, they carry data from around the country. There may be local offices for these companies.) If one of these services does not have the counties in your study region you may find that there is a service in your own community that maintains these types of records. Local real estate agencies or the local Board of Realtors would probably know about this. Alternatively, you could try calling local Tax Assessors and see if they have sold their data to this type of service.

Some of the Commercial Sources of Property Data are:

Experian Property Data (formally known as TRW)
3610 Central Avenue
Riverside, CA 92506
(800) 345-7334

Transamerica Information Management (offer a program called MetroScan)
1860 Howe Avenue, Suite 455
Sacramento, CA 98525
(800) 866-2783

DataQuick Information Services
9171 Towne Centre Drive, #404
San Diego, CA 92122
(800) 950-9171

The commercially available databases contain the same type of problems found in the County Assessor's data since they were obtained from them. Perhaps one of the main advantages of the commercially available data is that you can get some technical support in trying to put the data into databases. The software they provide enables you to look at individual properties or to sort properties in a variety of ways such as by zip code, or by census tract, or by age, or by occupancy to name a few. On the other hand, assessor's data are often stored on 9-track tape and little instruction is provided about how to extract the data.

One note of caution: The software that commercial services provide is limited in that you cannot extract the entire county at once. You are limited to extracting a certain number of records (for example 9000) at a time. A large county such as Los Angeles contains over two million records. Thus extracting all of the records for the county can be a tedious task, sometimes taking several days.

5.1.2 Occupancy to Building Type Relationships

Developing occupancy to model building type mapping schemes (in the General Occupancy Mapping Browser) that accurately reflect your study region will require combining available data with input from local experts. Collecting supplemental information about local building practices through the use of a questionnaire and/or a workshop is recommended.

5.1.3 Essential Facilities

Essential facilities, to a great degree, are owned or licensed by government agencies. Consequently, lists of these facilities often have been compiled for a region. Therefore, the time associated with collecting inventory on essential facilities may be relatively small; perhaps a day or two, if no building type information is collected and default occupancy to building type mappings are used. However, more detailed building type information may require a site visit for each facility. Some essential facilities are subject to special design and construction considerations that may help these structures perform better than the typical building when subjected to high winds.

5.1.3.1 Medical Care Facilities

Sources of inventory information for medical care facilities include the yellow pages of the telephone book, city and county emergency response offices, the American Hospital Association and previous loss studies. The default medical facilities database included with **HAZUS** was developed from a FEMA database and contains the number of beds for many of the facilities. Determining the number of beds for other facilities may require the user to contact facilities on an individual basis. In some cases, county guides, such as the McCormack Guides in California, provide a listing of all health care facilities, their addresses, phone numbers and the number of beds. The State Department of Public Health in California (and its equivalent in other states) licenses health care facilities and may publish a directory of licensed facilities.

5.1.3.2 Fire Stations, Police Stations and Emergency Operations Centers

Locations of fire stations, police stations and emergency operations centers can be obtained from city and county emergency response offices. In addition, many city maps show locations of police and fire stations.

5.1.3.3 Schools

Locations of public schools and their enrollments can be obtained from district offices. The Board of Education in some states compiles a directory of all schools (public and private) in the state with names, addresses, phone numbers and enrollments. The pages of the phone book can be used as an initial listing. Regional governments may compile directories of local educational institutions (including colleges and universities).

5.1.4 Used-Defined Facilities

User-defined facilities are those structures, other than essential facilities or high potential loss facilities, which the user may wish to analyze on a site-specific basis. For example, you may wish to identify all of the pharmacies in the community. You can collect data about these types of structures using the same sources you would use for general building stock or essential facilities, namely: specific databases that may be available to you through some agency, commercial sources of property data, the phone book, interviews with owners and site visits.

5.1.5 Demographics

Population statistics are used in estimating several different losses such as casualties, displaced households and shelter needs. Population location, as well as ethnicity, income level, age and home ownership is needed to make these estimates. The 2000 Census data are included with **HAZUS**. You may be able to obtain updated information from the Census Bureau or from a regional planning agency.

5.1.6 Direct Economic Loss Parameters

Direct economic losses begin with the cost of repair and replacement of damaged or destroyed buildings. However, building damage results in a number of consequential losses that are defined as direct economic losses. Thus, building-related direct economic losses (which are all expressed in dollars) comprise two groups. The first group consists of losses that are directly derived from building damage:

- Cost of repair and replacement of damaged and destroyed buildings
- Cost of damage to building contents
- Losses of building inventory (contents related to business activities)

The second group consists of losses that are related to the length of time the facility is non-operational (or the immediate economic consequences of damage):

- Relocation expense (for businesses and institutions) Capital-related income loss (a measure of the loss of services or sales)
- Wage loss (consistent with income loss)
- Rental income loss (to building owners)

5.1.6.1 County Business Patterns

County Business Patterns is an annual series published by the United States Census Bureau that presents state and county-level employment, annual payrolls, total number of establishments, and establishments by employee size. The data are tabulated by industry as defined by the Standard Industrial Classification (SIC) Code. Most economic divisions are covered, which include

agricultural services, mining, construction, manufacturing, transportation, public utilities, wholesale trade, retail trade, finance, insurance, real estate and services.

The data generally represents the types of employment covered by the Federal Insurance Contributions Act (FICA). Data for employees of establishments totally exempt from FICA are excluded, such as self-employed persons, domestic service employees, railroad employees, agricultural production employees and most government employees. County Business Patterns is the only complete source of sub-national data based on the four-digit SIC system. The series, therefore, is useful in making basic economic studies of small areas (counties), for analyzing the industrial structure of regions, and as a benchmark for statistical series, surveys and other economic databases. The data can serve a variety of business uses as well as being used by government agencies for administration and planning.

County Business Patterns data are extracted from the Standard Statistical Establishment List, a file of known single- and multi-establishment companies maintained and updated by the Bureau of the Census every year. The Annual Company Organization provides individual establishment data for multi-location firms. Data for single-location firms are obtained from various programs conducted by the Census Bureau as well as from administrative records of the Internal Revenue Service (Census Bureau, 1991).

5.1.6.2 Means Square Foot Costs

The default replacement costs supplied with the methodology were derived from Means Square Foot Costs for Residential, Commercial, Industrial, and Institutional buildings. The Means publication (Means, 2006) is a nationally accepted reference on building construction costs, which is published annually. This publication provides cost information for a number of low-rise residential model buildings, and for 70 other residential, commercial, institutional and industrial buildings. These are presented in a format that shows typical costs for each model building, showing variations by size of building, type of building structure, and building enclosure. One of these variations is chosen as "typical" for this model, and a breakdown is provided that shows the cost and percentages of each building system or component. The methodology also allows the user to adjust costs for location of the structure (e.g., New York and Miami). A description of how to estimate costs from the Means publication is found in the *Flood Model Technical Manual*. For **HAZUS-MH**, selected Means models have been chosen from the more than 70 models that represent the 33 occupancy types. The wide range of costs shown, even for a single model, emphasize the importance of understanding that the dollar values shown should only be used to represent costs of large aggregations of building types. If costs for single buildings or small groups (such as a college campus) are desired for more detailed loss analysis, then local building specific cost estimates should be used.

5.1.6.3 Dun and Bradstreet

Dun and Bradstreet is an organization that tracks all businesses that are incorporated. Dun and Bradstreet maintains data on the type of business, the number of employees, the square footage of the business, the annual sales and a variety of other information. The default square footage for the occupancy classes and for all the census tracts was created from the 2 and 4 digit (Standard Industrial Classification) SIC 2006 Dun and Bradstreet data. Dun and Bradstreet

provide aggregated information for a specific region on total number of employees, total annual sales and total square footage by census tract. They can also provide information on specific businesses.

5.1.6.4 Capital-Related Income

The U.S. Department of Commerce's Bureau of Economic Analysis reports regional estimates of capital-related income by economic sector. Capital-related income per square foot of floor space can then be derived by dividing income by the floor space occupied by a specific sector. Income will vary considerably depending on regional economic conditions. Therefore, default values need to be adjusted for local conditions.

5.2 Collecting Inventory Data

It should be understood that many available databases do not contain all of the information that is needed to perform a loss study. For example, they may contain street addresses, the size of the facility, or the value of the facility, but may not contain information about structural type or age. Databases may be out of date and may not contain all of the facilities in the region. Another problem the user can encounter is that databases may be in a paper rather than electronic format, making them difficult or impossible to use. Combining multiple databases can also be problematic. Issues such as double counting facilities and eliminating unnecessary information need to be addressed. In general, the majority of the building inventory used in the regional loss estimation will not be collected or kept on a facility-by-facility basis. Resource limitations make it difficult to collect such detailed information. Management and storage of such a large amount of information, while possible, is beyond the state-of-practice for many municipalities and government agencies. Maintaining facility-specific databases will be most useful for important or hazardous facilities such as hospitals, fire stations, emergency operation centers, facilities storing hazardous materials, and high occupancy facilities, to name a few. Procedures exist for supplementing facility-specific databases with area-specific inventory information. An example of an area specific inventory is the number of square feet of commercial space in a census tract or zip code. These area-specific inventories are often based on economic or land use information that is augmented using inference techniques. For example, the user may have available the number of commercial establishments in a region. Assuming an average size (in square feet) per establishment, the user can infer the total square footage of that occupancy. Similarly, a land use map may be converted to building square footage by multiplying land use area by percent of area covered by buildings.

Techniques for developing inventories include:

- Sidewalk/windshield surveys
- Analysis of land use data
- Analysis of aerial photography
- Discussions with local engineers and building officials

Chapter 6 Updating Inventory Data: Entering and Managing Data

HAZUS contains a variety of default parameters and databases. You can run a loss estimation analysis using only default data (Chapter 3), but your results will be subject to a great deal of uncertainty. If you wish to reduce the uncertainty associated with your results, you can augment or replace the default information with improved data collected for your region of study.

HAZUS contains two import tools for entering data: the stand-alone Building Information Tool (BIT) for improving general building stock (discussed in Chapter 8), and the import menu option for entering site-specific inventory dialogs (ex. hospitals, schools) and hazard data (ex. DEM). Data, which has not been imported, can still be used as overlays and for general spatial queries, but will not be treated in the loss estimation model.

As has been discussed in earlier sections, it is very likely that data obtained from different sources will not be in the same format. Furthermore, the data may contain a different number of fields than the data defined in **HAZUS**. This will require mapping the data fields to the correct format and inclusion in the centralized geodatabase. The following sections describe importing data, entering data through **HAZUS** windows, and managing the data.

6.1 Importing Features and Files

Only some offices and potential **HAZUS** users will have the most current version of GIS software; others will not currently use ESRI software. Those who have previously applied **HAZUS99** for Level II analysis will recognize the similarity of data field headers and inventory requirements. All operators of **HAZUS** will be starting with the newest default datasets; first to be evaluated, and then improved by directly editing the default inventories, or by importing new data files. Data that are not already formatted in GIS will require conversion to the standardized ESRI ArcGIS geodatabase format before importing.

6.1.1 Importing Site-Specific Data Files

ArcView feature classes, ArcInfo coverage files, CAD files, image files, and tabular database files (e.g., Paradox, dBase) must be converted to a geodatabase (*.mdb) for use with **HAZUS**. Several file types (e.g., shapefile, drawing, tabular) may be converted to one or more geodatabases for import. MapInfo, Atlas, or other CAD file formats will generally require exporting files to a shapefile format in order to bring them into ArcGIS. Images or files designated for reference only can still be added as a simple layer for use in displays, and need not be imported. Data intended for consideration by the loss estimation model must be imported. ArcCatalog, ArcMap, or MS-Access can be used for this purpose.

Select the inventory you wish to improve from the **HAZUS** Inventory menu and begin editing. Using the mouse, right-click on a browser. The “Import” option (Figure 6.1) will appear in the pop-up menu and you can select this feature. Enter the directory and filename for the database you wish to import, as in Figure 6.2.

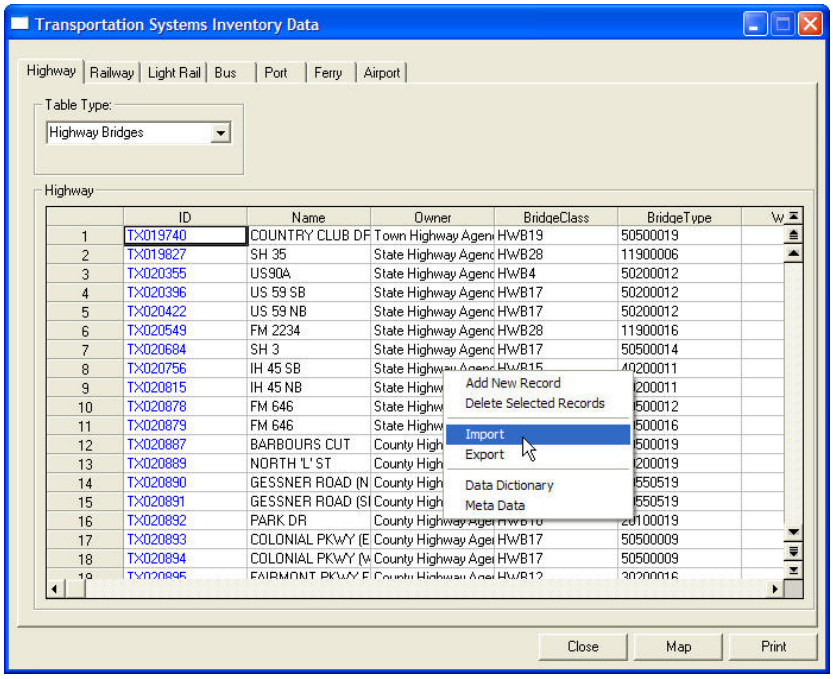


Figure 6.1 Import Features with Attributes

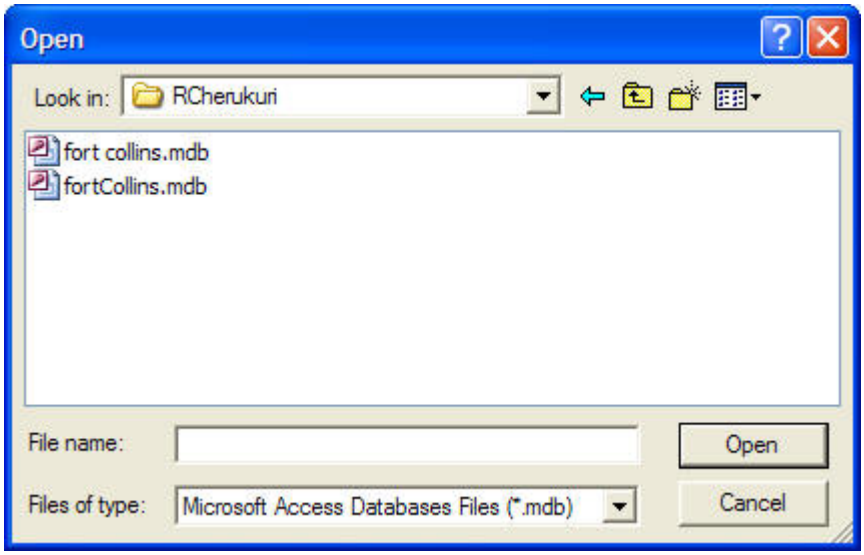


Figure 6.2 Identify the Database to be Imported

There are two important issues to keep in mind regarding the import of Microsoft Access databases to HAZUS. First is that the Access database should be stored on a ***local*** drive. The second is that any tables to be used should have no spaces in their names. Violation of either of these two rules will result in an import failure.

6.1.2 The Import Database Utility

A database import utility has been developed to assist you in converting an electronic database to the appropriate format for **HAZUS**. Clicking on the right mouse button accesses this import utility. The Database Management Tools menu (the pop-up menu), shown in Figure 6.1, will appear. Select the **Import database** and click on the name of the file you want to import; click the **OK** button.

The mapping window shown in Figure 6.3 is used to map the each field in your database (the source) to the corresponding field used in the **HAZUS** database (the target database). The Database Dictionary in Appendix D contains the names and structures of all of the databases that are used by **HAZUS**. From the Database Dictionary you can determine the names of the target fields. The Database Dictionary, in an abbreviated form, is available interactively in **HAZUS**. To access it, click on the right mouse button; using the same menu shown in Figure 6.1, click on **Data Dictionary**. An example from the Database Dictionary is shown in Figure 6.4.

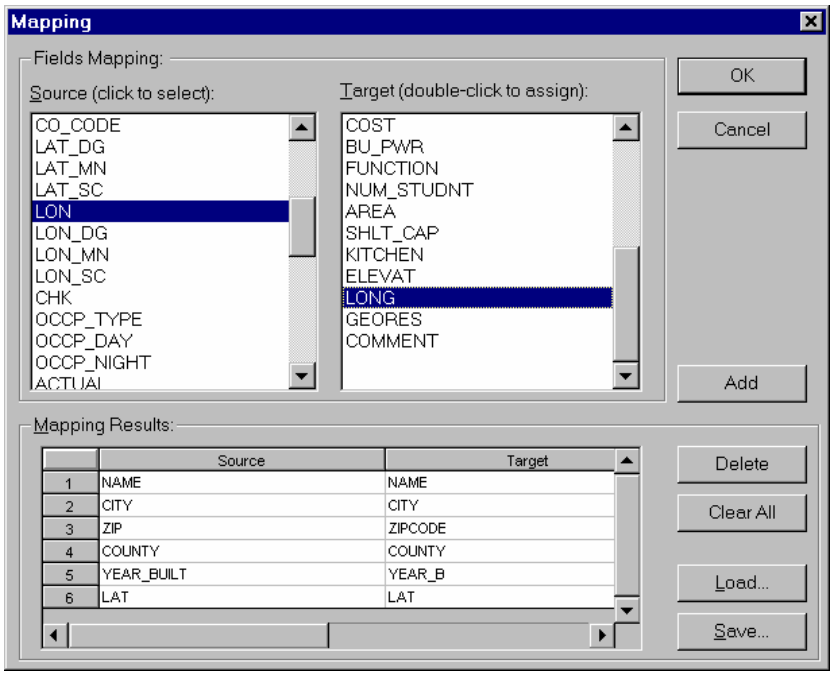


Figure 6.3 Mapping the Fields of your Data File to the HAZUS Data Structure

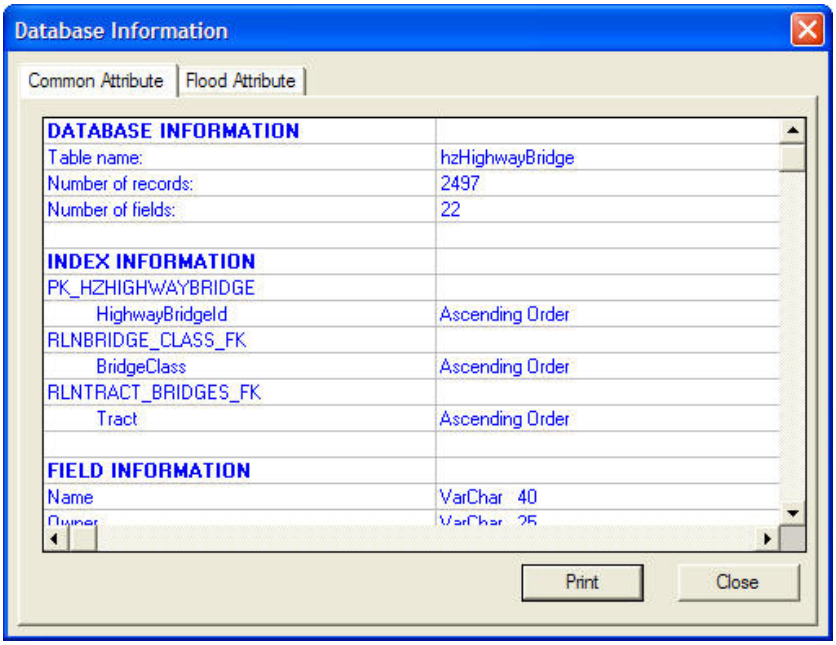


Figure 6.4 Interactive Database Dictionary

The fields from the **Source** menu do not have to be in the same order nor do they have to have the same names as the fields in the **Target** menu. For example, in Figure 6.3, the year the school was built is in a field called "YEAR_BUILT" in the **Source** file, whereas the field that contains this information is in the "YEAR_B" field in the **Target** file. To define the desired mapping scheme, simply click on a field name from the **Source** menu (e.g., LON) and the corresponding field name from the **Target** menu (e.g., LONG); then click on the **Add** button.

After performing these steps, the mapping you have defined will disappear from the **Source** and **Target** menus and will appear in the **Mapping Results** box at the bottom of the window. If you make a mistake, click the **Delete** button, and the last mapping pair you have defined will be undone. In this example, the user has already defined six relationships and is in the process of defining a seventh. When you have completed defining all of the information, click on the **OK** button, wait a few seconds, and your imported database will be displayed in **HAZUS**. You do not have to map all of the fields from the **Source** menu. However, any fields you do not map will not be imported into the **Target** database.

It is possible to have several databases with the same format. To save the mapping that you have defined so that it can be reapplied to other files, click the **Save** button in Figure 6.3 and the dialog box shown in Figure 6.5 will appear. Enter a name for the mapping scheme and click the **OK** button. To retrieve the saved mapping, click on the **Load** button in Figure 6.3.

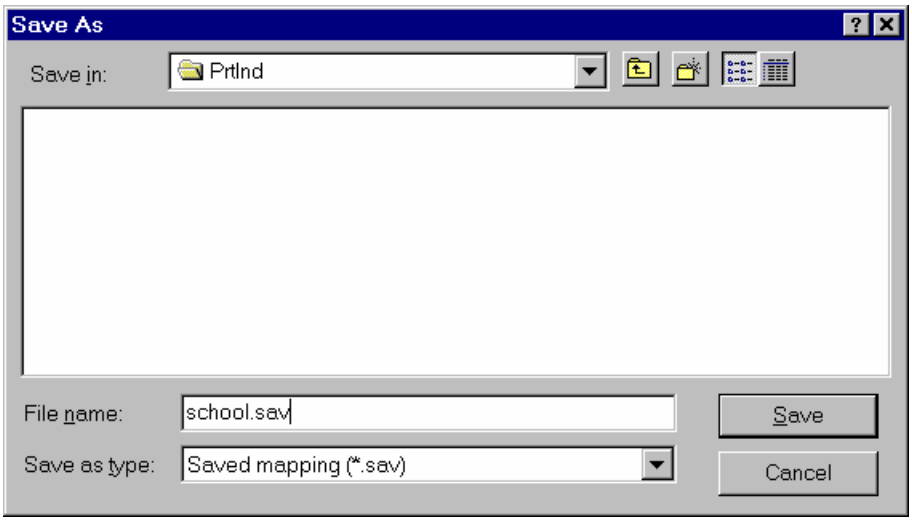


Figure 6.5 Saving a Database Mapping Scheme

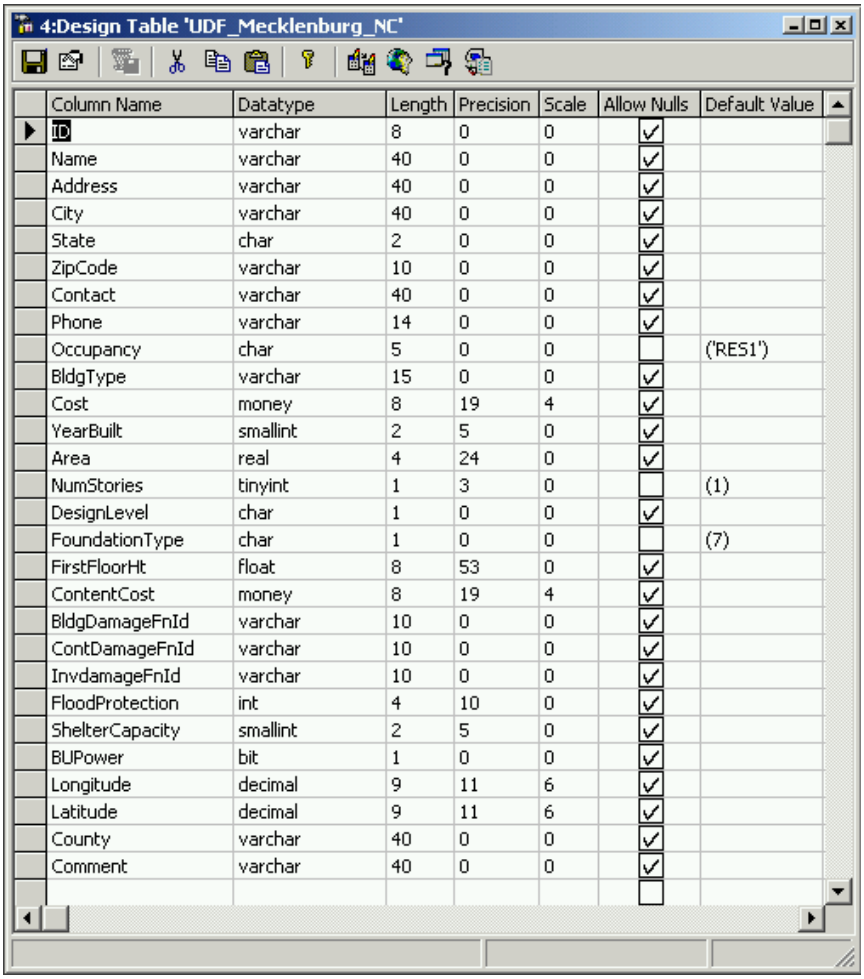
6.1.3 Pre-processing Inventory Point Data

Users can easily import the User Defined Facility (UDF) information to **HAZUS** Region Database. The UDF table has to follow four requirements:

1. Necessary data:
   - ❖ GIS Parcels file (Shape file)
   - ❖ HAZUS Occupancy Code (Access table)

2. Pre-process the dataset:
   - ❖ Subset the Parcels in the flood plain only (easy and time-saving process)
   - ❖ Extract center coordinates (Lat/Long) for each flooded parcel (with GIS or other map systems)
   - ❖ Clean (correct errors) and group by (ID) the HAZUS occupancy code

3. User Defined Facility table format and data type on SQL Server (or MS-Access) as seen in Figures 6.6 and 6.7:



Column Name	Datatype	Length	Precision	Scale	Allow Nulls	Default Value
ID	varchar	8	0	0	☑	
Name	varchar	40	0	0	☑	
Address	varchar	40	0	0	☑	
City	varchar	40	0	0	☑	
State	char	2	0	0	☑	
ZipCode	varchar	10	0	0	☑	
Contact	varchar	40	0	0	☑	
Phone	varchar	14	0	0	☑	
Occupancy	char	5	0	0	☐	('RES1')
BldgType	varchar	15	0	0	☑	
Cost	money	8	19	4	☑	
YearBuilt	smallint	2	5	0	☑	
Area	real	4	24	0	☑	
NumStories	tinyint	1	3	0	☐	(1)
DesignLevel	char	1	0	0	☑	
FoundationType	char	1	0	0	☐	(7)
FirstFloorHt	float	8	53	0	☑	
ContentCost	money	8	19	4	☑	
BldgDamageFnId	varchar	10	0	0	☑	
ContDamageFnId	varchar	10	0	0	☑	
InvdamageFnId	varchar	10	0	0	☑	
FloodProtection	int	4	10	0	☑	
ShelterCapacity	smallint	2	5	0	☑	
BUPower	bit	1	0	0	☑	
Longitude	decimal	9	11	6	☑	
Latitude	decimal	9	11	6	☑	
County	varchar	40	0	0	☑	
Comment	varchar	40	0	0	☑	
					☐	

Figure 6.6 UDF Table Field Definitions (as seen in SQL Server)

UDF_Mecklenburg_NC : Table

Field Name	Data Type	Description
ID	Text	Field Size: 8
Name	Text	Field Size: 40
Address	Text	Field Size: 40
City	Text	Field Size: 40
State	Text	Field Size: 2
ZipCode	Text	Field Size: 10
Contact	Text	Field Size: 40
Phone	Text	Field Size: 14
Occupancy	Text	Field Size: 5
BldgType	Text	Field Size: 15
Cost	Currency	Field Size:
YearBuilt	Number	Field Size: Integer
Area	Number	Field Size: Single
NumStories	Number	Field Size: Byte
DesignLevel	Text	Field Size: 1
FoundationType	Text	Field Size: 1
FirstFloorHt	Number	Field Size: Double
ContentCost	Currency	Field Size:
BldgDamageFnId	Text	Field Size: 10
ContDamageFnId	Text	Field Size: 10
InvdamageFnId	Text	Field Size: 10
FloodProtection	Number	Field Size: Long Integer
ShelterCapacity	Number	Field Size: Integer
BUPower	Yes/No	Field Size:
Longitude	Number	Field Size: Decimal (11,6)
Latitude	Number	Field Size: Decimal (11,6)
County	Text	Field Size: 40
Comment	Text	Field Size: 40

Figure 6.7 UDF Table Field Definitions (as seen in MS-Access)

4. Extraction for UDF table:
   - Extract the necessary information from the two data source tables (Flooded_Parcels & HAZUS Occupancy code) based on structure of the above UDF table.
   - Fields distribution type:
     a. HAZUS distribution fields include: **NumStories**, **DesignLevel**, **FoundationType**, **FirstFloorHt** and **ContentCost** (see above figure)
     b. Parcels information and default fields are the remaining (see above figure)
   - Most County Tax Assessor's files have square footage and the value of a building. The following are recommended data to complete a UDF. The columns on the left show what the user's data might look like and the column on the right shows how it is implemented into **HAZUS**. A note on how to extract HAZUS distribution fields as seen in Tables 6.1, 6.2, 6.3, 6.4 and 6.5:

a. **NumStories**: based on occupancy and original number of stories of the parcels

Table 6.1 NumStories Field Description

Occupancy	Number of Stories From Parcels	NumStories
RES1	1	1
	2	2
	3	3
	Split level	4
RES2	1	1
	2	2
	3	3
RES3	1-2	1
	3-4	3
	5+	5
All others (including RES4 to EDU2)	1-3	1
	4-7	4
	8+	8

b. **DesignLevel**: depends on the **YearBuilt**

Table 6.2 DesignLevel Field Description

YearBuilt	Design Level
Prior – 1950	1
1950 – 1970	2
Post 1970	3
0 (set to Null)	0

c. **FoundationType**: based on the real foundation type in the parcels

Table 6.3 FoundationType Field Description

Real Foundation Type	FoundationType	Basement
Pile	1	0
Pier	2	0
Solid Wall	3	0
Basement /Yard	4	1
Crawl Space	5	0
Fill	6	0
Slab on Grade	7	0

d. **FirstFloorHt**:

Table 6.4 FirstFloorHt Field Description

FoundationType	FirstFloorHt [ft]
Pile	7
Pier	5
Solid Wall	7
Basement /Yard	4
Crawl Space	3
Fill	2
Slab on Grade	1

e. **ContentCost**: depends on cost and occupancy

Table 6.5 ContentCost Field Description

Occupancy	ContentCost
RES1 To RES6 & COM10	Cost * 0.5
COM1 To COM5, COM8, COM9, IND6, AGR1, REL1, GOV1 and EDU1	Cost * 1.0
COM6 To COM7, IND1 To IND5, GOV2 and EDU2	Cost * 1.5

❖ Set these default constraints:

a. **YearBuilt = Null**
   It is recommended that the user look for the trends of surrounding buildings and set the YearBuilt to the trend or to set it to 1970.
b. **Occupancy = 'RES1'**
   It is recommended that the user look for the trends of surrounding buildings and set the Occupancy to the trend.
c. **NumStories = 1**
d. **Foundationty = 7**
e. **FloodProtection = 0**
   If the building is near a dam or a dike, set the FloodProtection to that level.
f. Other fields:
   The most fields extract from the Flooded Parcels directly or query combinations with HAZUS Occupancy Code

- The hzUserDefinedFacility table is linked to the flUserDefinedFacility table. Below in Table 6.6, users can see how the different fields are mapped in the two tables. The **UDEFImportSchema.SAV** file source-target field mapping:

Table 6.6 UDF Field Mapping Schema

MS Access	MSSQL	Type
CONTACT	CONTACT	hz
NAME	NAME	hz
ADDRESS	ADDRESS	hz
CITY	CITY	hz
STATE	STATE	hz
ZIPCODE	ZIPCODE	hz
PHONE	PHONENUMBER	hz
OCCUPANCY	OCCUPANCY	hz
YEARBUILT	YEARBUILT	hz
COST	COST	hz
BUPOWER	BACKUPPOWER	hz
NUMSTORIES	NUMSTORIES	hz
AREA	AREA	hz
BLDGTYPE	BLDGTYPE	fl
LATITUDE	LATITUDE	hz
LONGITUDE	LONGITUDE	hz
COMMENT	COMMENT	hz
CONTENTCOST	CONTENTCOST	hz
DESIGNLEVEL	DESIGNLEVEL	fl
FOUNDATIONTYPE	FOUNDATIONTYPE	fl
FIRSTFLOORHT	FIRSTFLOORHT	fl
SHELTERCAPACITY	SHELTERCAPACITY	hz
BLDGDAMAGEFNID	BLDGDAMAGEFNID	fl
CONTDAMAGEFNID	CONTDAMAGEFNID	fl
INVDAMAGEFNID	INVDAMAGEFNID	fl
FLOODPROTECTION	FLOODPROTECTION	fl

6.2 Adding Records to Site Specific Databases

In addition to importing entire datasets, you can add one or more site-specific (point) feature records at a time to improve inventories of essential facilities, high potential loss facilities, lifeline components and facilities storing hazardous materials. When you identify a new site, you will need to add a new feature record with attributes. To add linear lifeline features, see Section 6.5.

6.2.1 Adding Features Using the Study Region Map

You will notice that feature locations are listed in the ArcMap attribute table without the entire set of feature attributes. **HAZUS** stores attributes other than the each feature identifier and coordinates using SQL Server. This design for feature and attribute storage is for efficiency, and allows for anticipated expansion to interactive web-based delivery of the program. The database design requires you to add features in the following steps:

1. **Start Editing** using the ArcMap Editor toolbar.
2. Select the appropriate and available database (e.g., util.mdb for editing utility facilities).
3. Add features.
4. Select **Save** and **Stop Editing** features.
5. Open **HAZUS** Inventory menu and select the appropriate inventory (e.g., utilities).
6. Add attributes to each new feature record by placing the cursor in the desired field.
   Notes:
   a. The feature ID field cannot be edited.
   b. Several fields include a pick list for standardized data entry (see Figure 6.11)

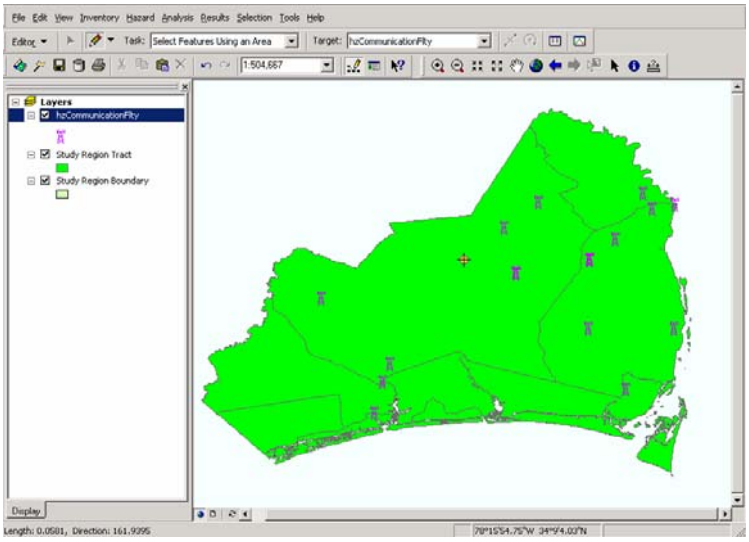


Figure 6.8 Add Site-specific Feature

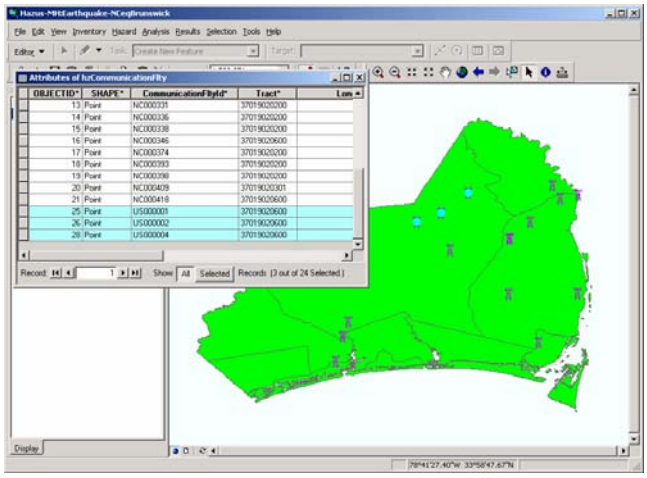


Figure 6.9 Add feature using ArcMap Edit Tool

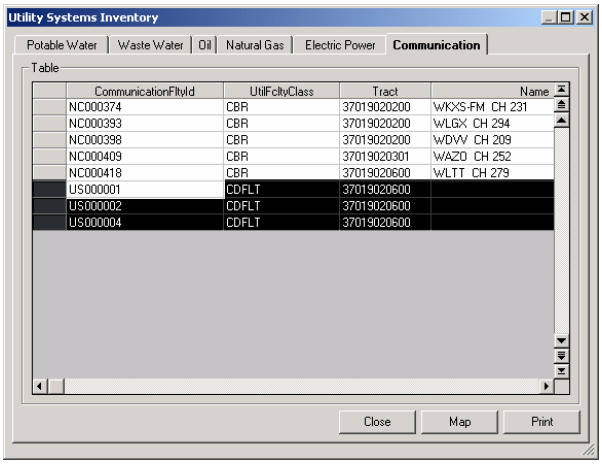


Figure 6.10 Add Attributes under HAZUS Inventory Menu

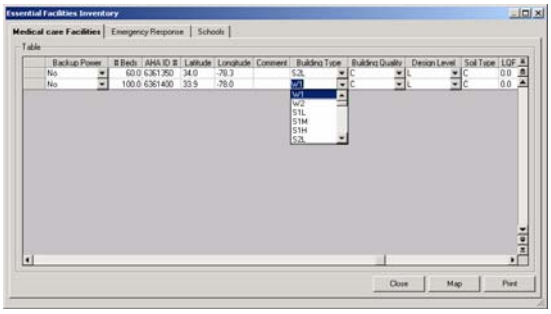


Figure 6.11 Use Attribute Pick Lists Where Available

The site-specific, or facility inventories have many more data fields than are required for estimating potential losses. The additional information is beneficial to the overall analysis, and cost-efficient to collect along with the minimum data required to run **HAZUS**. At minimum, the

required fields for each database are specified in Appendix D. **HAZUS** will automatically assign the first four data fields (indicated with a "*") when records are added graphically. The ID numbers are associated with a particular facility, and are required for reporting the study results.

6.2.2 Adding Records to the Attribute Table

The one essential datum element ***required*** to define a facility is its location. If its location was not added graphically (see Figure 6.8), the only other way to define a facility location in **HAZUS** is to type the longitude and latitude of the facility, as in Figure 6.12. If you don't know the longitude and latitude of the facility, you will need to use a geocoder[1] to get the longitude and latitude of the location and then add it to the database in **HAZUS**. Once you have defined a location, click on the **OK** button and the new point feature will be saved.

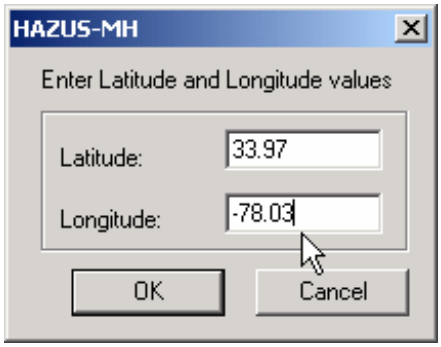


Figure 6.12 Add Record Latitude/Longitude Coordinates

When the location has been entered, a default set of attributes will be assigned to each new record, in the event no other detail is available. For example, **HAZUS** assumes a generic default bridge class of HDFLT if no bridge class is supplied. To complete the new records using improved information, fill in the required fields using the pick lists provided for standardized data entry (see Figure 6.11). Complete the data fields that do not have a pick list with the best available information.

To save the new added records to the database, right-click and select **Stop Editing**. **HAZUS** will prompt for confirmation and will save the data to the hard-disk.

[1] The geocoding process is performed outside HAZUS. Any commercial geocoder application can be used.

6.2.3 Errors When Adding Records

HAZUS is very strict about enforcing the rule that *all inventory data points must fall within the study region boundary*. If you define facility locations that are outside the study region, **HAZUS** deletes them and displays the dialog show in Figure 6.13.

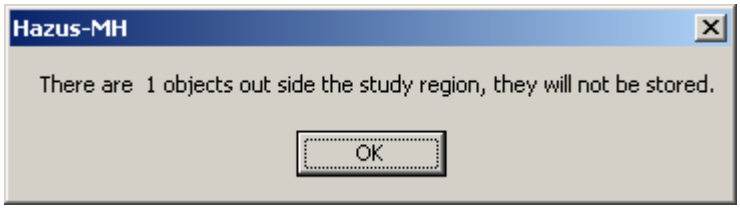


Figure 6.13 Sites Added Outside the Study Region will not be Accepted

6.3 Deleting Records from Site Specific Databases

Select the record to be deleted from a database by clicking on the record marker on the left side of the record ID. When the records have been selected, use the right mouse button to display the database management options shown in Figure 6.14, and choose **Delete Selected Records**.

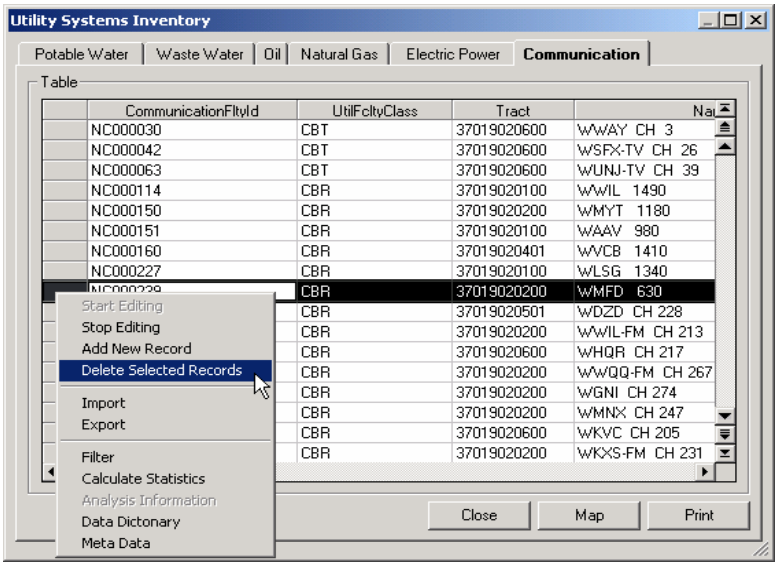


Figure 6.14 Select and Delete Records from a Facility Database

6.4 Editing Records

Attributes associated with default, or improved point and line features can be edited directly in **HAZUS**. Open the **HAZUS** menu **Inventory** and choose the database to edit. Double clicking the mouse on the desired cell, and replacing the text to be modified can edit data within a record. In order to minimize errors, use the pick lists to fill in the value whenever a list is offered (see Figure 6.11)

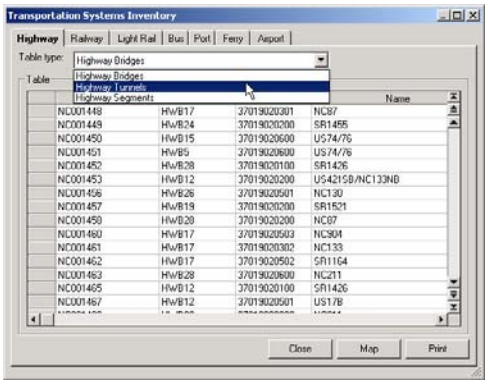


Figure 6.15 Edit Default Inventory

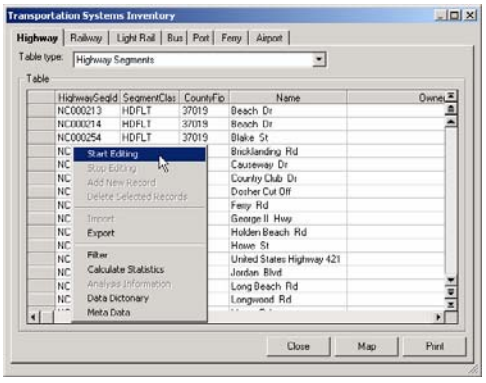


Figure 6.16 Menu Option to Start Editing

Alternatively, choosing **Start Editing** from the ArcMap **Editor** toolbar can move a structure's location. In edit mode, use one of ArcMap's selection buttons to isolate the facility of interest. With your feature selected and mouse button held down, drag and drop the facility symbol from its old location to the desired new location. To delete a location, select the facility on the map and press the <**Delete**> key. The feature and all associated attributes in the inventory database will be deleted.

You can move or delete multiple records at one time. To do so, use the ArcMap selection tools to select by location. You can draw a box around several sites to select a group; or, select a single structure by clicking on each location, one at a time, while holding the <**Shift**> key down. When all the locations have been selected, release the <**Shift**> key and follow the above steps for deleting or moving a record. When finished, click on the **Editor** toolbar and select **Stop Editing**. You will be asked to confirm (or dismiss) your changes to the database.

6.5 Adding Lifeline Segments

Lifeline segments must be created using ArcMap **Editor** tools. To add lifeline segments (ex. highway, railway, light rail, etc.) you must be familiar with the functionality of the "Editor" in ArcMap. Refer to the ArcMap documentation for details.

Chapter 7 Modifying Inventory Data

This section guides you through the process of modifying inventory data in the **HAZUS** program. Following guidance in Sections 4 and 5, you may now have collected community-specific data that describes your local community more accurately than the default data included with the **HAZUS** program. Section 6 discusses ways to process specific forms of digital data to work with the **HAZUS** program. Here, you will get a detailed look at successfully modifying the inventory databases needed to run a flood loss analysis in **HAZUS**.

This section does not describe how to modify flood hazard data. The Flood Information Tool (FIT) program, which is included as part of the **HAZUS** software, should be used to modify flood hazard data and analysis, not inventory data. The FIT is briefly introduced in Section 4, an overview is given in Section 9, and comes with its own, detailed manual.

The default data in **HAZUS** can be directly modified entry by entry in the **HAZUS** program. Alternately, existing databases from other sources can be imported into **HAZUS** following the guidelines given in Section 6. Both approaches to modifying data are discussed in this Section.

7.1 Modifying General Building Stock Data

There a several categories of general building stock data: basic data, financial data, and flood specific occupancy mapping. Basic data, referring to building square footage, building count, and occupancy category, should be modified by using the Building-Data Information Tool (BIT), as explained below and in detail in Section 8. Financial data and flood specific occupancy mapping should be modified within the **HAZUS** program. The sections below guide you through this process.

7.1.1 Building Square Footage, Count and Occupancy Category

To modify the basic building data of square footage, building count and general occupancy, you should use the Building-Data Information Tool (BIT). This tool, which processes databases in a variety of forms into the proper **HAZUS** format, is explained in Section 8.

7.1.2 Building Financial Data

Building financial data appear in four listings under the *Inventory* menu and *General Building Stock* submenu: *Valuation Parameters*, *Dollar Exposure*, *Depreciation Parameters*, and *Depreciated Exposure*.

The data in the *Valuation Parameters* tables are the key parameters used to estimate the values of structures by specific occupancy type. The detailed formula used to calculate these estimates is presented in the technical manual. You cannot change these valuation parameters. Instead, if you have improved data on the replacement costs of buildings in your study region, you should directly overwrite the *Dollar Exposure* tables.

There are two ways to replace the default data for building dollar exposure. The first is to directly edit the tables in **HAZUS**. The second is to import a file with the improved data. Note that you have these two choices for many tables in **HAZUS**.

7.1.3 Edit General Building Stock (GBS) Tables

Directly editing the data tables in **HAZUS** is a good idea if you have improved data for only a few census blocks. For larger amounts of data, it is probably more efficient to create a database in another program and import it into **HAZUS**.

When the dollar exposure window is visible, showing data by specific occupancy type, you can type directly over data in black text (all text presented in blue is non-editable). When you close this window, you will be prompted to save your changes, shown in Figure 7.1. By clicking *Yes*, you have edited the table.

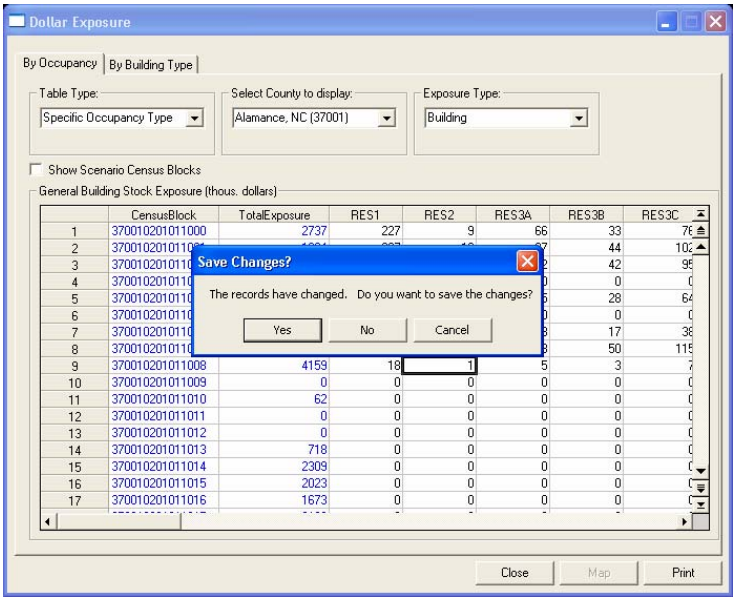


Figure 7.1 Prompt to Save Changes After Editing GBS Dollar Exposure Table

7.1.4 Import Data File

Instructions for importing a data file can be found in Section 6.1.3.

7.1.5 General Occupancy Mapping

General occupancy mapping tables contain data on the building type for each occupancy type. **HAZUS** comes with one default mapping scheme and every Census Block is assigned a default mapping scheme.

When you select the *Inventory* menu, *General Building Stock* submenu, *General Occupancy Mapping*, the window shown in Figure 7.2 appears. In the top right portion of the window, you can view the default scheme assigned to each census block in your study region. By selecting the scheme listed in the lower window and pressing **View**, you can see the details of the mapping scheme.

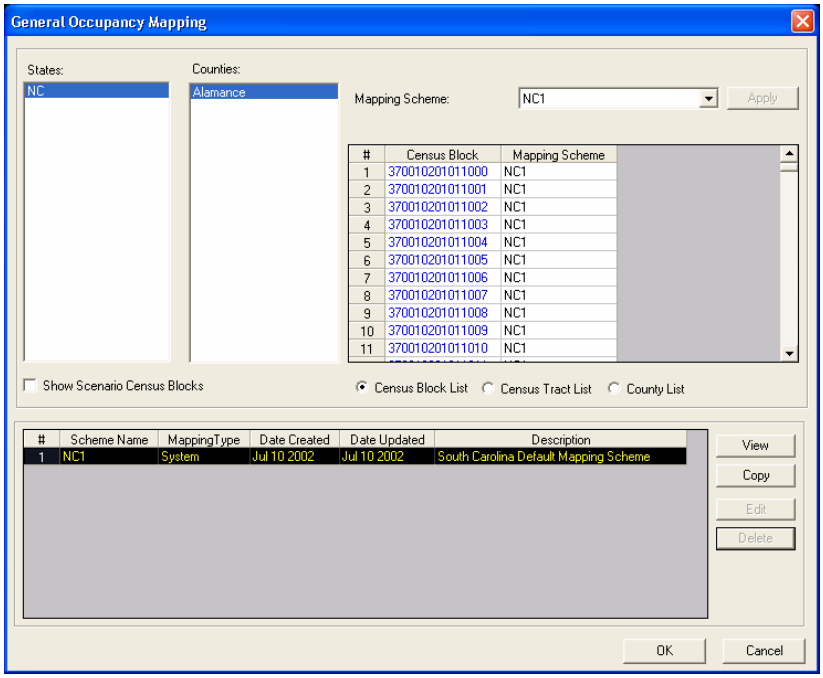


Figure 7.2 Default General Occupancy Mapping (TEMP)

To edit the mapping scheme, highlight the scheme in the lower part of the window and click **Copy**. A new window will pop-up prompting you to name your copied scheme, as shown in Figure 7.3. Select any name and add a description if you wish. This will create a new scheme with exactly the same data as one of the **HAZUS** default scheme, which can be edited. The pull-down menu at the bottom of the *New Mapping Scheme* window will allow you to select the default mapping scheme as your starting point.

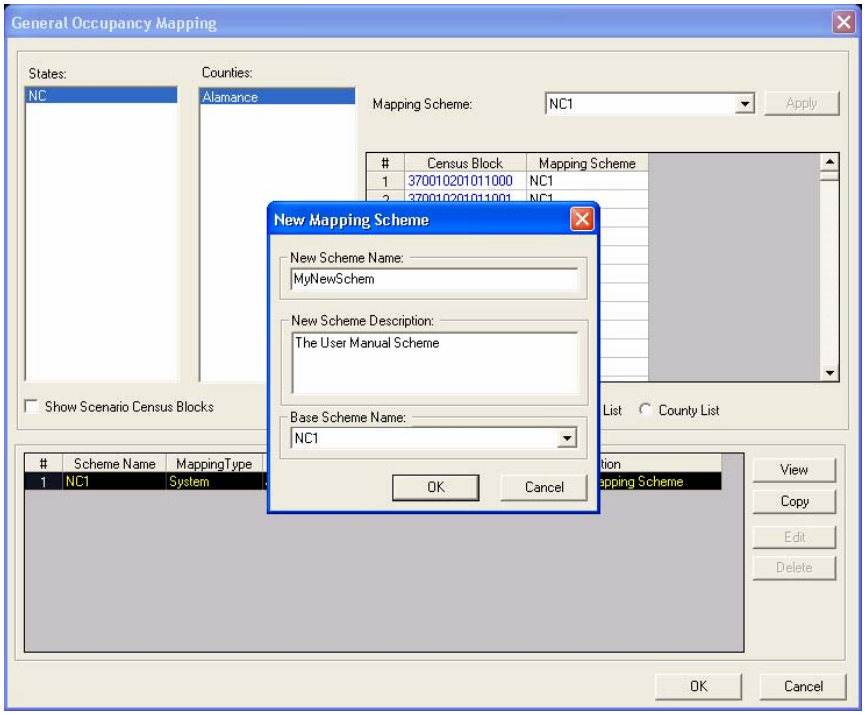


Figure 7.3 Copying a General Occupancy Mapping Scheme (TEMP)

Your new mapping scheme is now listed as one of the options in the bottom window. Highlight your new scheme and click **Edit**. The general occupancy mapping details will appear on the screen. You can select each occupancy type and edit the distribution of building types. When you have made all of your edits, click **OK**.

Next, you need to assign your new mapping scheme to the relevant areas in your study region. The scheme that was developed now appears under the *Mapping Scheme* pull-down menu as shown in Figure 7.4. Select the new scheme you have created in the *Mapping Scheme* pull-down menu. Then, highlight all of the census blocks that you would like to have your new mapping scheme assigned to, and click **Apply**. The mapping scheme should change for these census blocks. If you need to assign your new mapping scheme to the entire study region, click on the radial dial for *County List*. Select the new scheme in the *Mapping Scheme* pull-down menu, and click **Apply**.

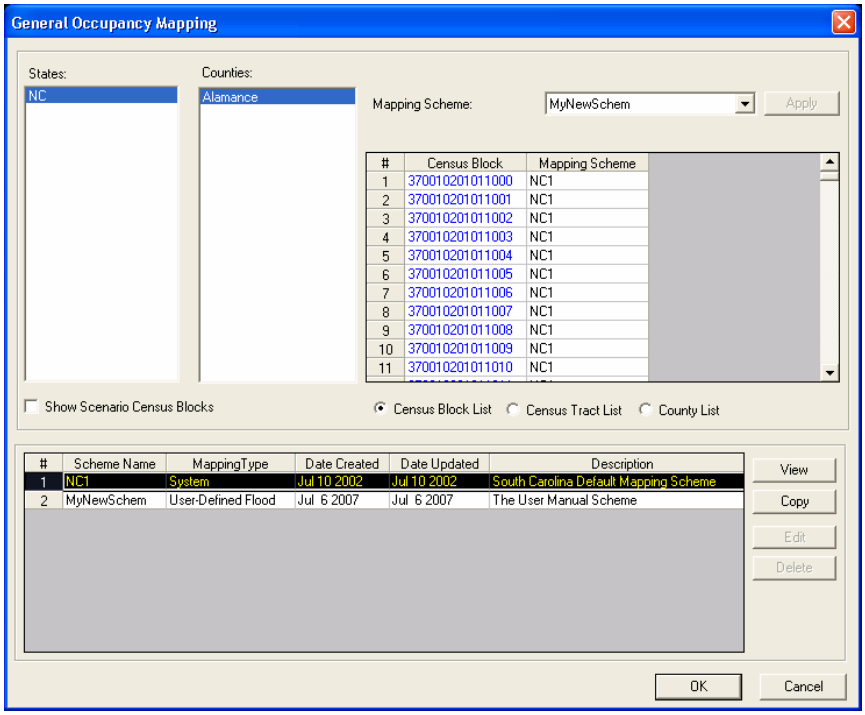


Figure 7.4 Assigning Newly Created General Occupancy Mapping

7.1.6 Flood Specific Occupancy Mapping

Flood specific occupancy mapping tables contain data on the types of foundations and average heights of first floors above grade for each specific occupancy type. **HAZUS** comes with three default mapping schemes and every Census Block is assigned a default mapping scheme.

When you select the *Inventory* menu, *General Building Stock* submenu, *Flood Specific Occupancy Mapping*, the window shown in Figure 7.5 appears. In the top right portion of the window, you can view which of the default schemes is assigned to each census block in your study region. By selecting one of the schemes listed in the lower window and pressing **View**, you can see the details of the mapping scheme.

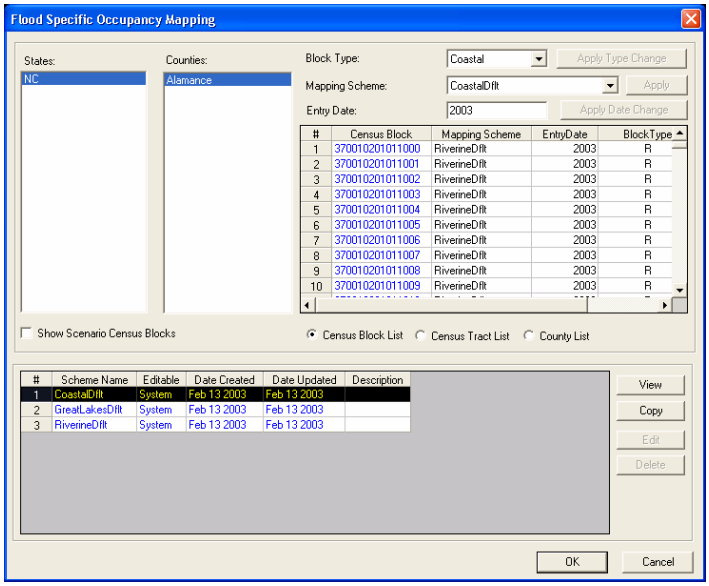


Figure 7.5 Default Flood Specific Occupancy Mapping (TEMP)

To edit a mapping scheme, highlight one scheme in the lower part of the window and click **Copy**. A new window will pop-up prompting you to name your copied scheme, as shown in Figure 7.6. Select any name and add a description if you wish. This will create a new scheme with exactly the same data as one of the **HAZUS** default schemes, which can be edited. The pull-down menu at the bottom of the *New Mapping Scheme* window will allow you to select which mapping scheme you would like as your starting point. You should select the default-mapping scheme that is relevant for the type of flood hazard present in your study region; riverine, coastal or great lakes.

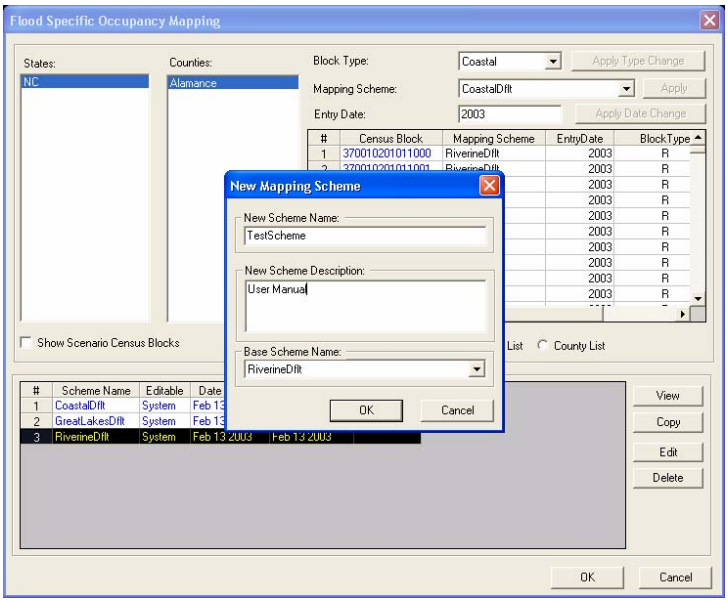


Figure 7.6 Copying a Flood Specific Mapping Scheme (TEMP)

Your new mapping scheme is now listed as one of the options in the bottom window. Highlight your new scheme and click **Edit**. The flood specific occupancy mapping details will appear on the screen. You can select each specific occupancy type and edit the distribution of foundation types and floor heights for pre- and post-FIRM structures. When you have made all of your edits, click **OK**.

Next, you need to assign your new mapping scheme to the relevant areas in your study region. The scheme that was developed in the example for this manual was riverine, and now appears under the *Mapping Scheme* pull-down menu when *Riverine* is selected in the *Hazard Type* pull-down menu, shown in Figure 7.7. Select the new scheme you have created in the *Mapping Scheme* pull-down menu. Then, highlight all of the census blocks that you would like to have your new mapping scheme assigned to, and click **Apply**. The mapping scheme should change for these census blocks. If you need to assign your new mapping scheme to the entire study region, click on the radial dial for *County List*. Select the new scheme in the *Mapping Scheme* pull-down menu, and click **Apply**.

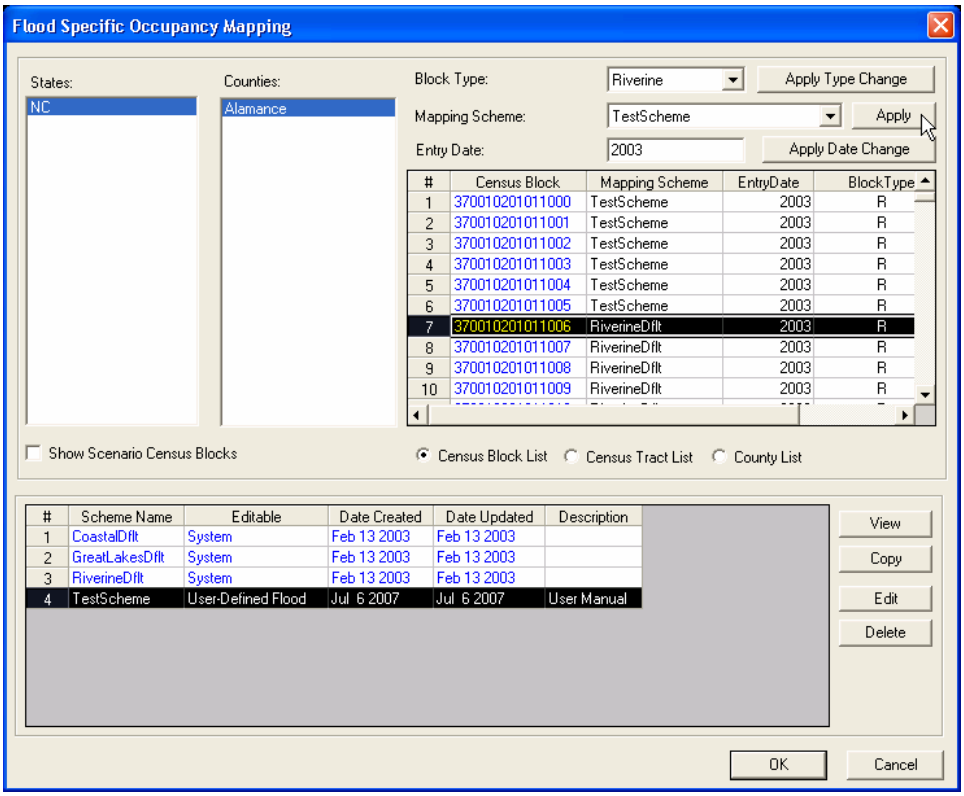


Figure 7.7 Assigning Newly Created Flood Occupancy Mapping

7.2 Modifying Facilities, Lifeline and Hazardous Materials Data

Data for essential facilities, high potential loss facilities, transportation systems, utility systems and hazardous materials can all be modified in similar ways. Again, you can modify them directly in **HAZUS** or by importing data from other databases.

7.2.1 Edit Facilities, Lifeline and Hazardous Materials Tables

This manual will use emergency operations centers as an example data set to edit. Access the default data for essential facilities by selecting *Essential Facilities* from the *Inventory* menu, and click on the *Emergency Centers* tab on the top of the window. Make sure that *Emergency Centers* is selected in the *Facility-Type* pull-down menu.

You may edit the default data about emergency centers directly by typing over existing data. Be sure to save changes when you close the window.

It is also possible to add or delete records in the database. Place your cursor anywhere on the window and click on the right-hand mouse button. To add a record, select *Add New Record* from the window that pops up, shown in Figure 7.8.

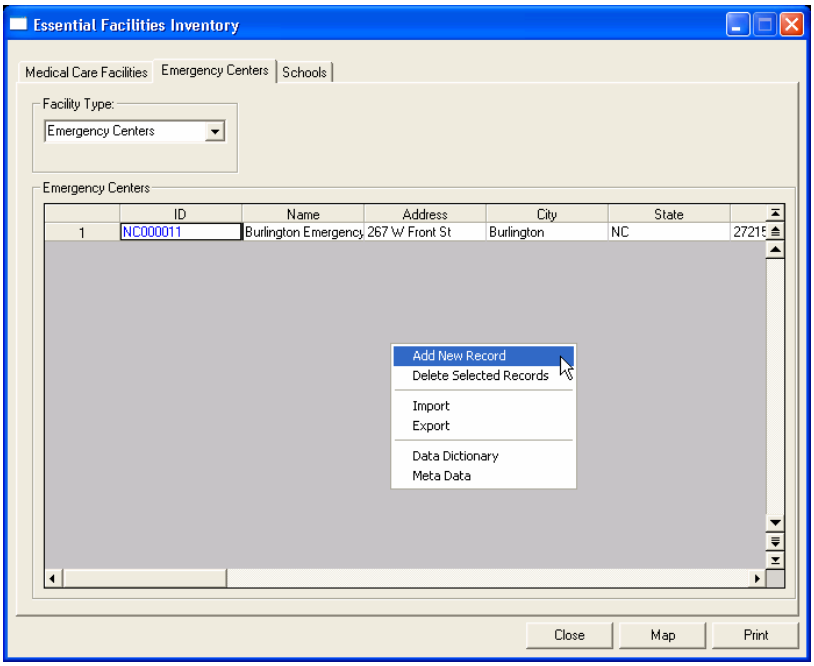


Figure 7.8 Adding a New Record

Now you will be prompted to enter the latitude and longitude of the new emergency center, shown in Figure 7.9. You must select a latitude and longitude within the case study boundary. Note that longitude should be entered as a negative number.

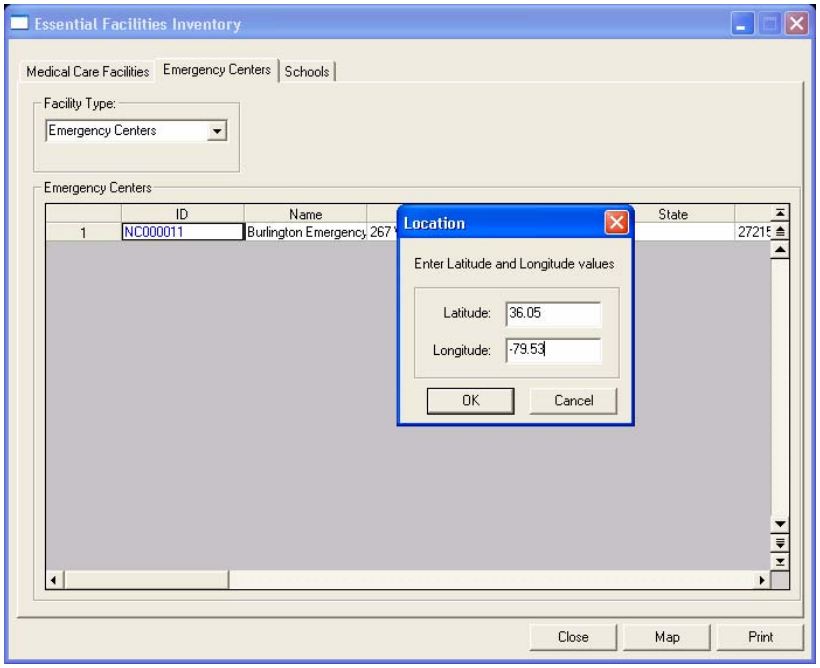


Figure 7.9 Entering Latitude and Longitude of a New Facility

A new line will appear, shown in Figure 7.10, and you may enter all of the relevant data about the newly listed facility.

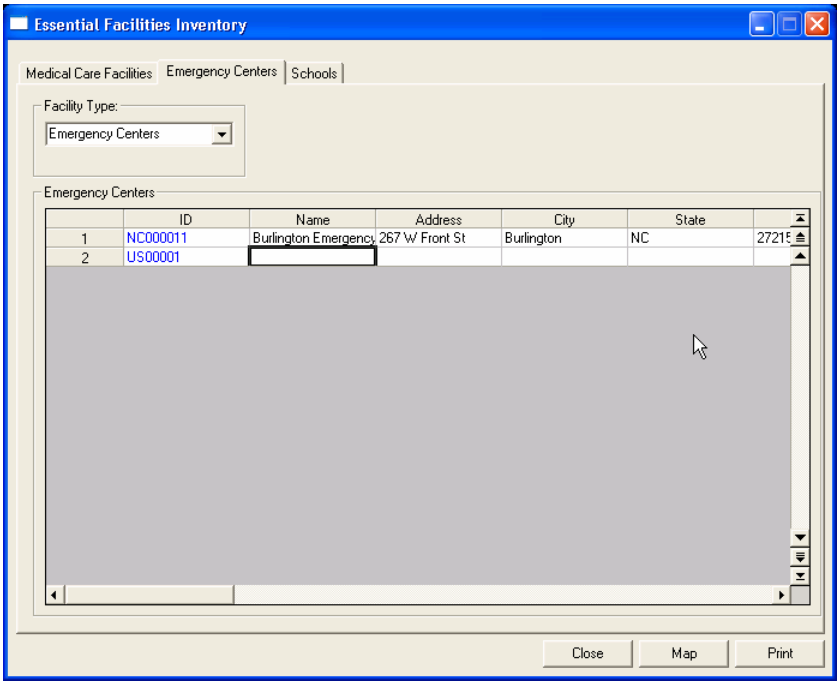


Figure 7.10 New Record Added for Data Entry

7.2.2 Importing Site Specific Data through Open Database Connectivity (ODBC)

Users can import an MS Access table into HAZUS. However, there are rules for the table field definitions. Perhaps the easiest way is to copy the field definitions from HAZUS and then add your custom data. This can be done using Open Database Connectivity (ODBC). Using ODBC allows users to bypass InCAST in an attempt to import the data in my Study Region MS SQL Server database. Begin by opening MS Access. Under the *File* menu, select *New/Create New Database*. Then save the new database on a local drive (it's important that it is not saved to a network drive).

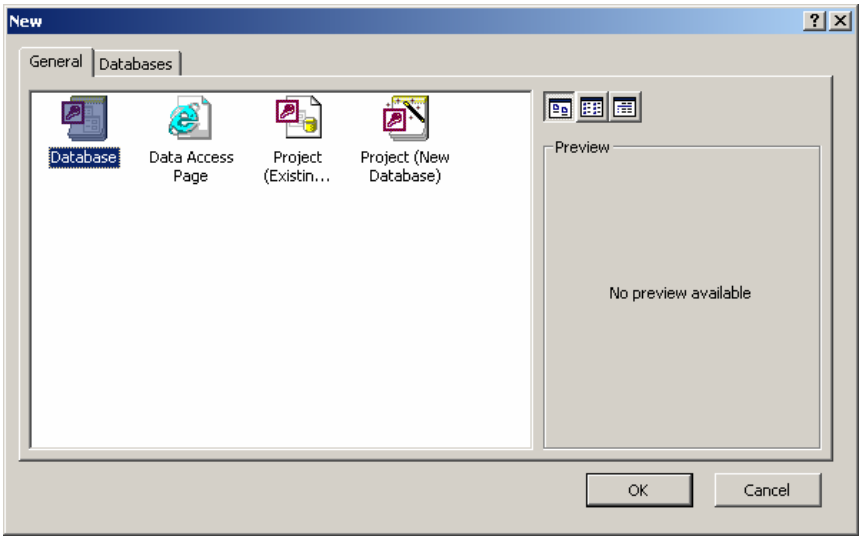


Figure 7.11 Creating a New MS Access Database

After the new Access database has been saved to disk, go to the **File** menu and select **Get External Data/Import**. In the resulting dialog, in the combo box titled "Files of Type", scroll to the bottom and select ODBC Databases. Click the *Import* Button.

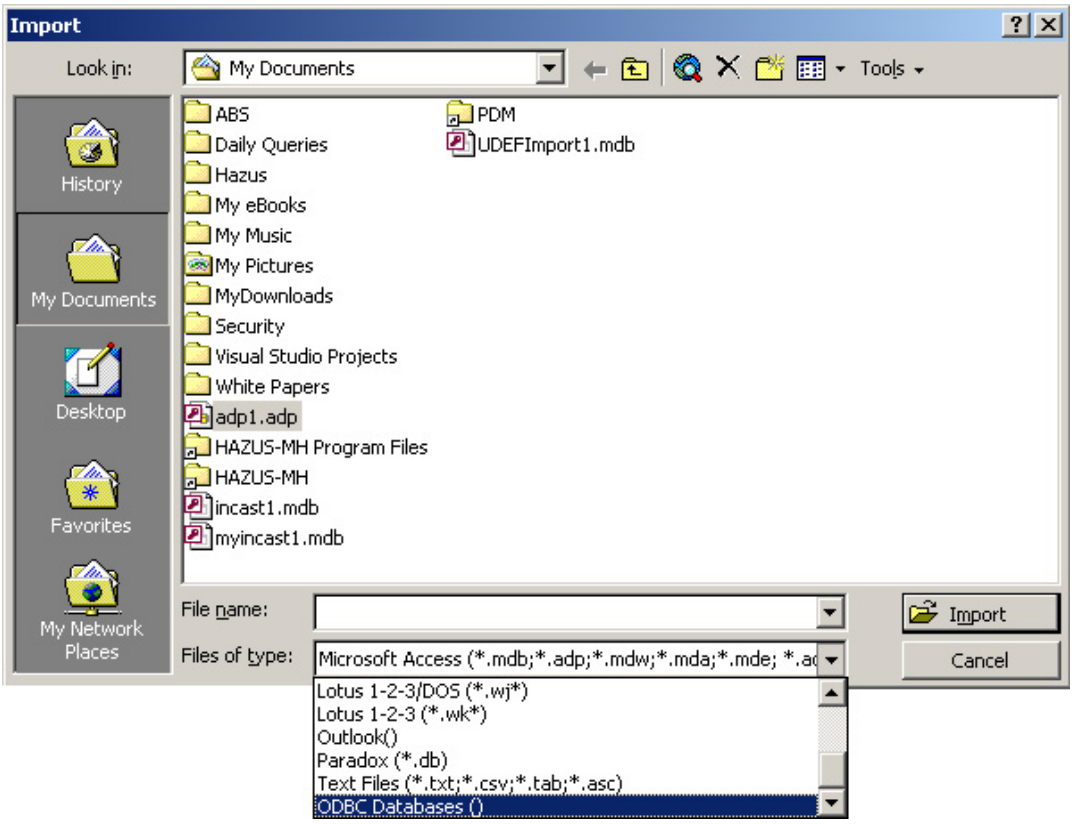


Figure 7.12 Importing an ODBC Database

After clicking Import, the resulting dialog is titled “Select Data Source.” Select the **Machine Data Source** tab and click the **New** button.

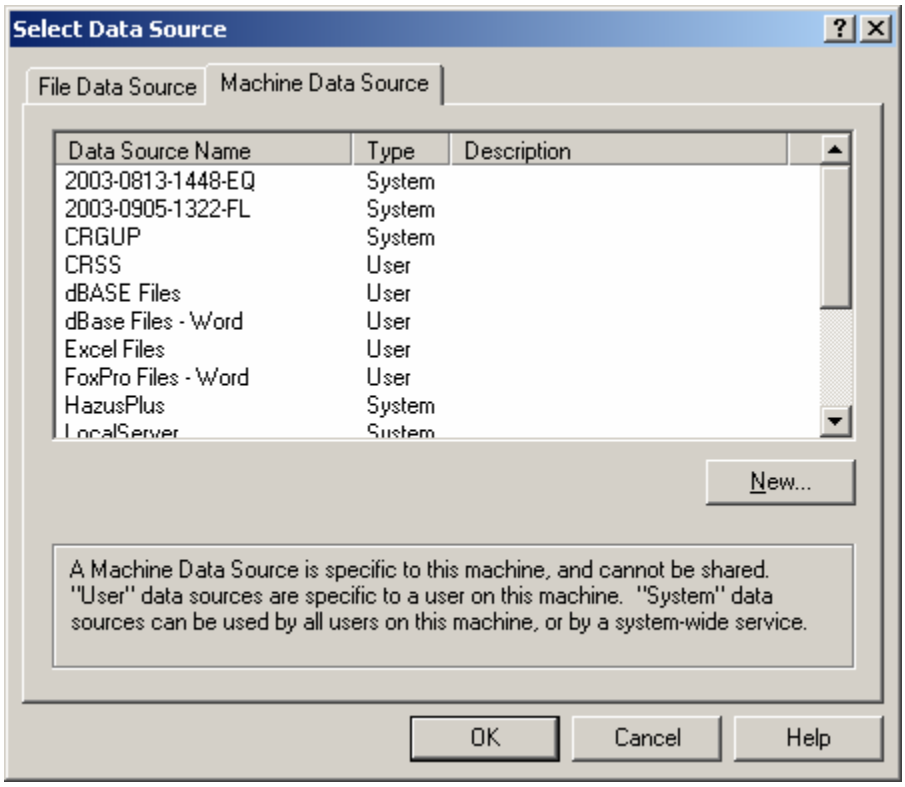


Figure 7.13 ODBC: Machine Data Source

In the Create Data Source dialog, select **System Data Source** (applies to this machine only), and the **Next** button.

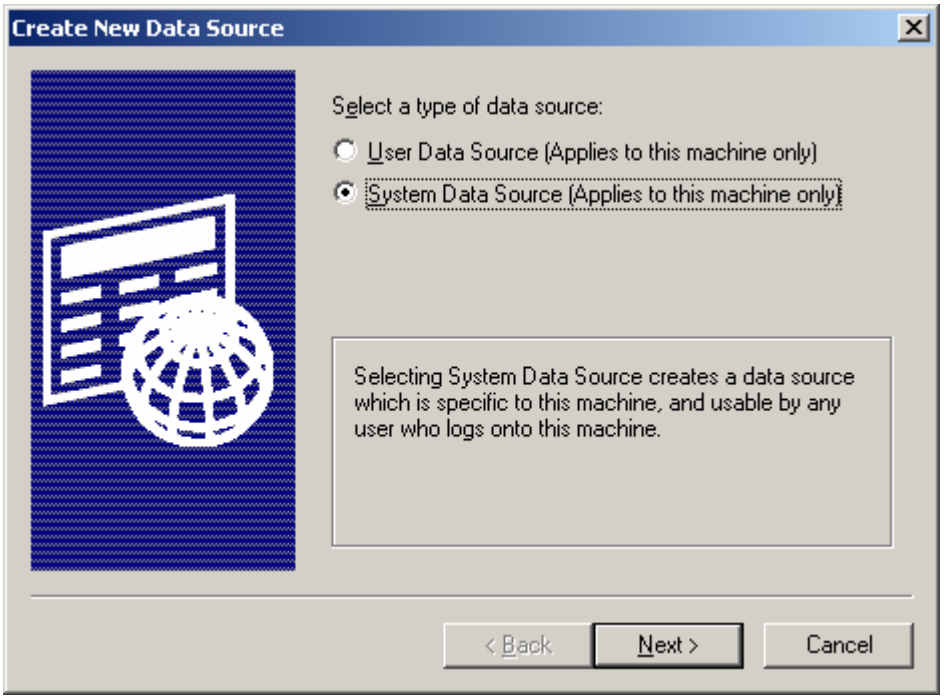

Create New Data Source
Select a type of data source:
User Data Source (Applies to this machine only)
System Data Source (Applies to this machine only)
Selecting System Data Source creates a data source which is specific to this machine, and usable by any user who logs onto this machine.
< Back
Next >
Cancel

Figure 7.14 ODBC: New Data Source Type

The resulting dialog asks to select the data source driver. At the bottom, select **SQL Server** and click the next button. On the next dialog, click **Finish**.

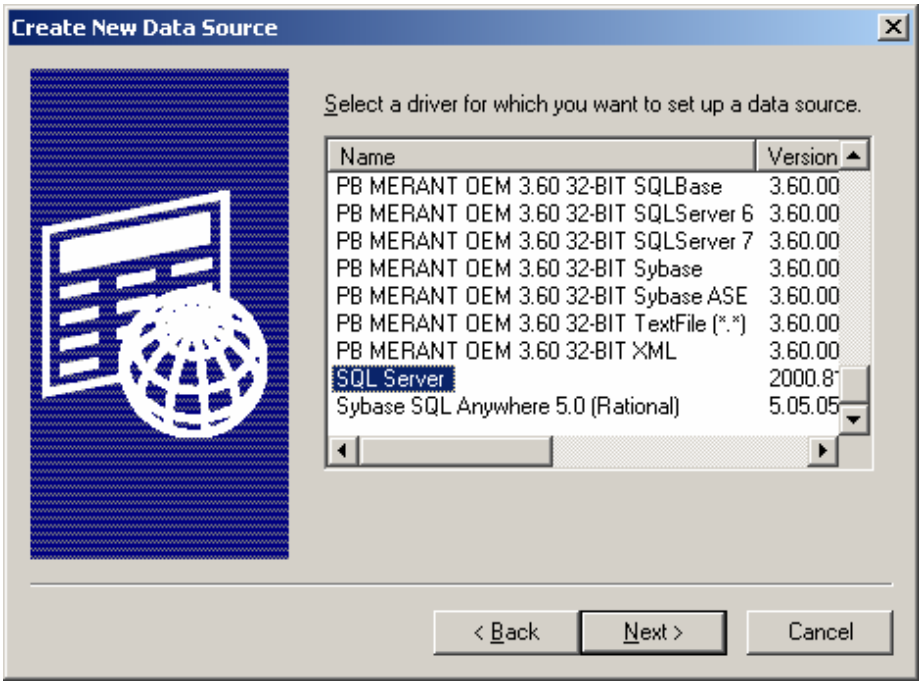

Create New Data Source
Select a driver for which you want to set up a data source.
Name
Version
PB MERANT OEM 3.60 32-BIT SQLBase 3.60.00
PB MERANT OEM 3.60 32-BIT SQLServer 6 3.60.00
PB MERANT OEM 3.60 32-BIT SQLServer 7 3.60.00
PB MERANT OEM 3.60 32-BIT Sybase 3.60.00
PB MERANT OEM 3.60 32-BIT Sybase ASE 3.60.00
PB MERANT OEM 3.60 32-BIT TextFile (*.*) 3.60.00
PB MERANT OEM 3.60 32-BIT XML 3.60.00
SQL Server 2000.8
Sybase SQL Anywhere 5.0 (Rational) 5.05.05
< Back
Next >
Cancel

Figure 7.15 ODBC: New Data Source Server

The next few dialogs of the Create New Data Source wizard will prompt you for details about the new ODBC source. First you will enter the connection and server names. Keep the **Name**, short (preferably no spaces or special characters). A good choice for the name is that of your study region. The **Description** is optional, but here you can add a more descriptive name. In the **Server** combo box, select your MS SQL Server name. If your MS SQL Server name is not shown in the combo box, type your machine name followed by (no spaces) **"\HAZUSPLUSSRVR**". Then click the **Next** button.

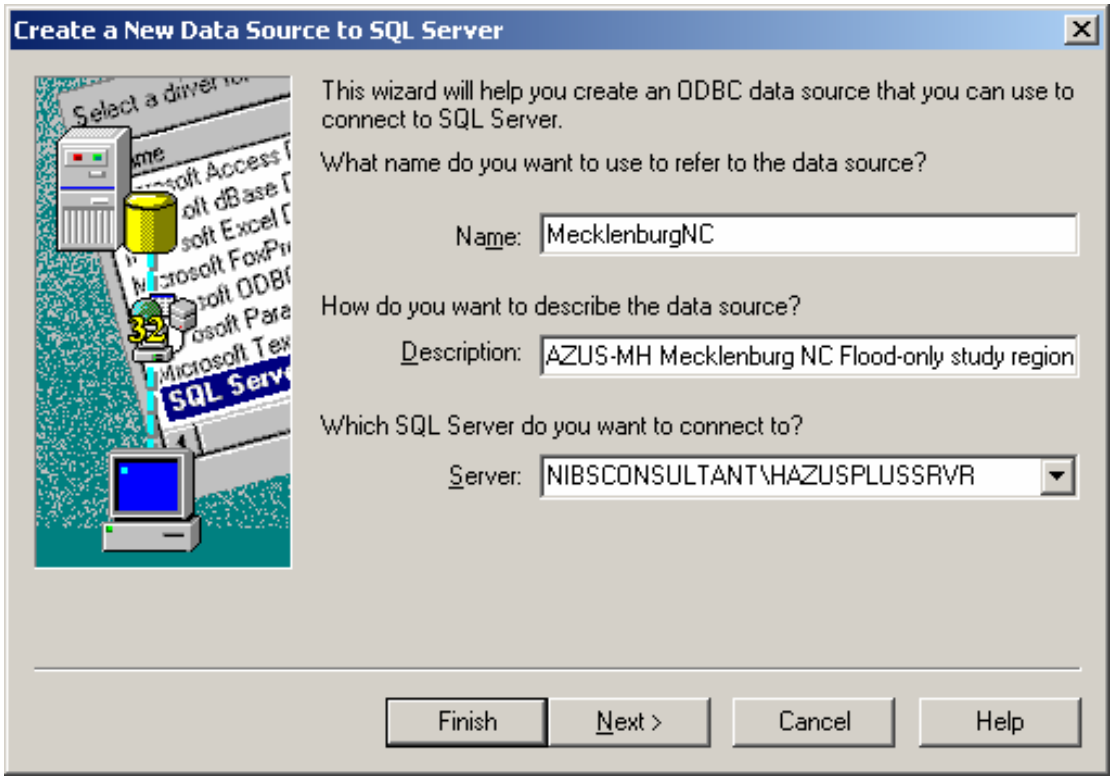

Create a New Data Source to SQL Server
This wizard will help you create an ODBC data source that you can use to connect to SQL Server.
What name do you want to use to refer to the data source?
Name: MecklenburgNC
How do you want to describe the data source?
Description: AZUS-MH Mecklenburg NC Flood-only study region
Which SQL Server do you want to connect to?
Server: NIBSCONSULTANT\HAZUSPLUSSRVR
Finish
Next >
Cancel
Help

Figure 7.16 ODBC: Connection and Server Names

The wizard next asks for login authenticity information. For simplicity, use Windows authenticity. However, you may also use SQL Server authenticity with a login ID of **hazuspuser** and a password of **gohazusplus!!!** Click the next button.

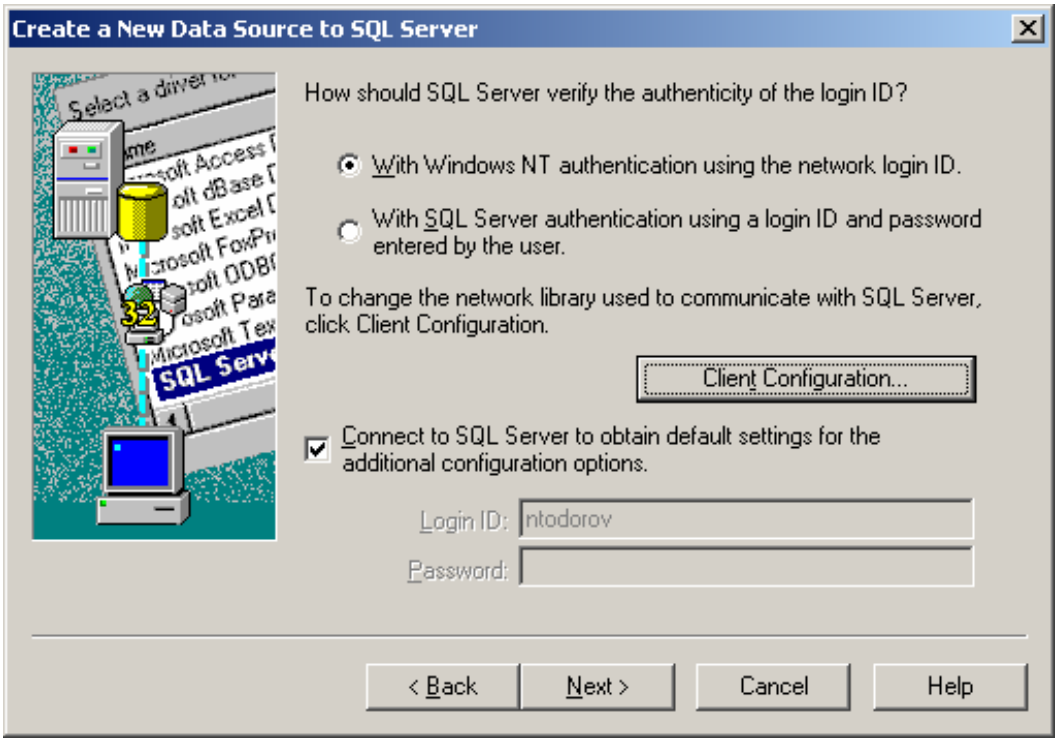

Create a New Data Source to SQL Server
How should SQL Server verify the authenticity of the login ID?
With Windows NT authentication using the network login ID.
With SQL Server authentication using a login ID and password entered by the user.
To change the network library used to communicate with SQL Server, click Client Configuration.
Client Configuration...
Connect to SQL Server to obtain default settings for the additional configuration options.
Login ID:
ntodorov
Password:
< Back
Next >
Cancel
Help

Figure 7.17 ODBC: Login Authenticity

The next dialog asks information about the SQL Server database. To avoid connecting to the MS SQL Server master database, **Change the default database**. In the combo box, select or type the name of your study region database (same as the study region name). Click the **Next** button. In the next dialog, use the defaults and click the **Finish** button.

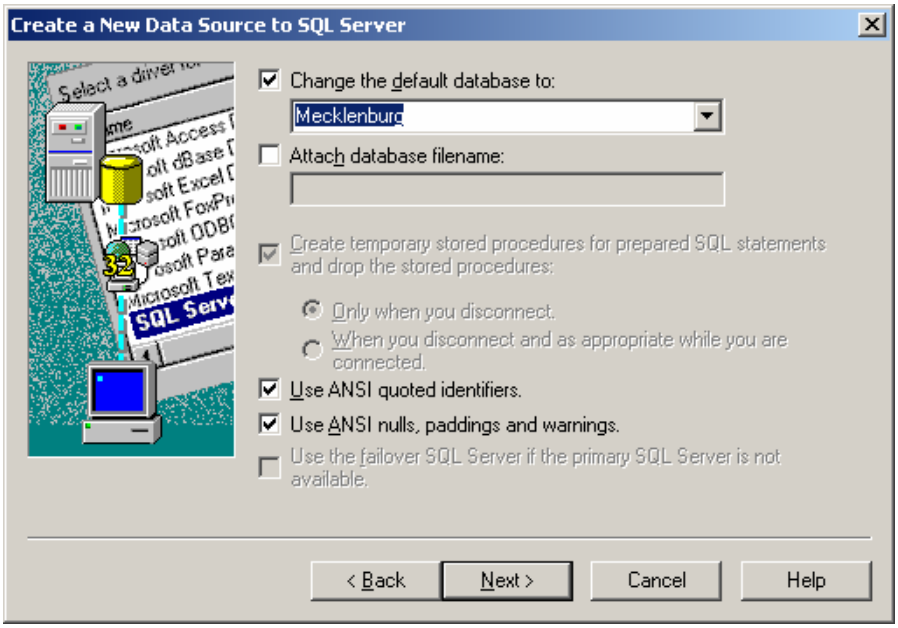

Create a New Data Source to SQL Server
Change the default database to:
Mecklenburg
Attach database filename:
Create temporary stored procedures for prepared SQL statements and drop the stored procedures:
Only when you disconnect.
When you disconnect and as appropriate while you are connected.
Use ANSI quoted identifiers.
Use ANSI nulls, paddings and warnings.
Use the failover SQL Server if the primary SQL Server is not available.
< Back
Next >
Cancel
Help

Figure 7.18 ODBC: SQL Server Default Database

At this point, the ODBC wizard has collected the required information and displays it. Before dismissing the dialog, click on the **Test Data Source** button to verify the study region's connectivity parameters. Then click the **OK** button.

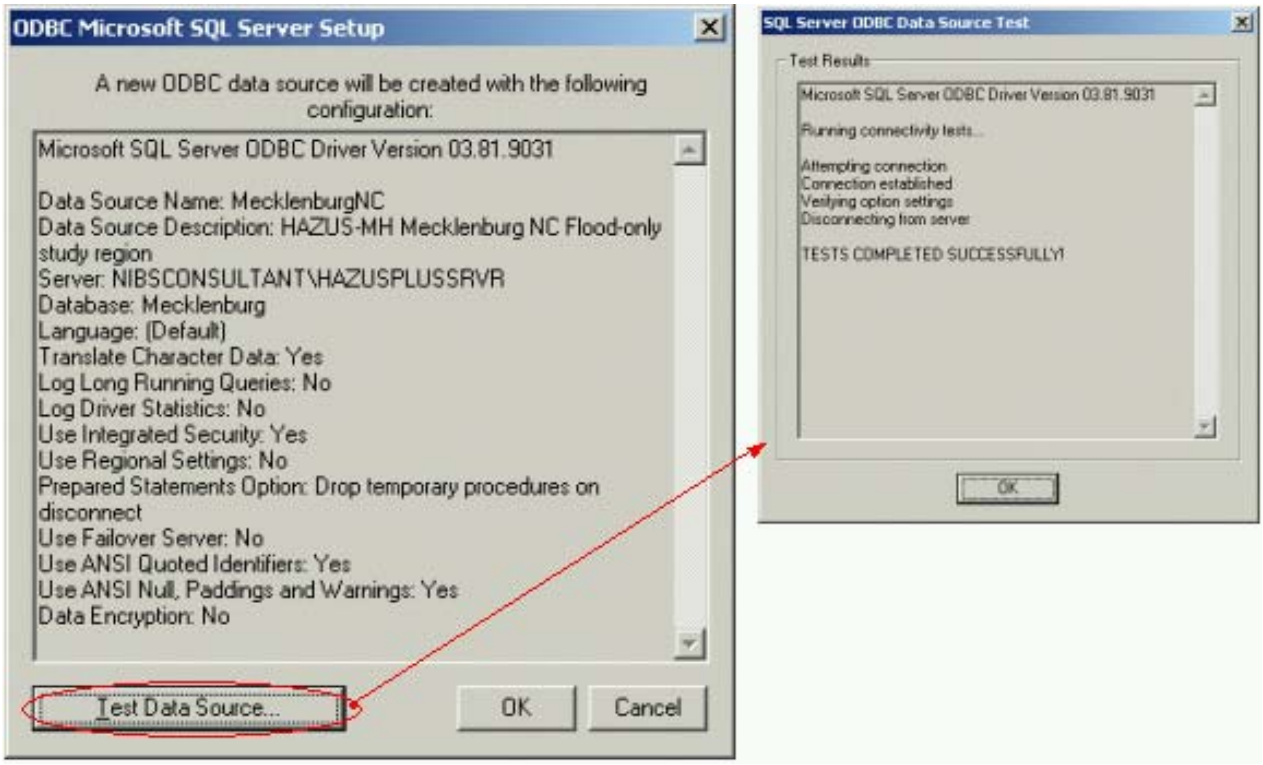

ODBC Microsoft SQL Server Setup
A new ODBC data source will be created with the following configuration:
Microsoft SQL Server ODBC Driver Version 03.81.9031
Data Source Name: MecklenburgNC
Data Source Description: HAZUS-MH Mecklenburg NC Flood-only study region
Server: NIBSCONSULTANT\HAZUSPLUSSRVR
Database: Mecklenburg
Language: (Default)
Translate Character Data: Yes
Log Long Running Queries: No
Log Driver Statistics: No
Use Integrated Security: Yes
Use Regional Settings: No
Prepared Statements Option: Drop temporary procedures on disconnect
Use Failover Server: No
Use ANSI Quoted Identifiers: Yes
Use ANSI Null, Paddings and Warnings: Yes
Data Encryption: No
Test Data Source...
OK
Cancel
SQL Server ODBC Data Source Test
Test Results
Microsoft SQL Server ODBC Driver Version 03.81.9031
Running connectivity tests...
Attempting connection
Connection established
Verifying option settings
Disconnecting from server
TESTS COMPLETED SUCCESSFULLY!
OK

Figure 7.19 ODBC: Connectivity Parameters

Now we return to the Select Data Source dialog we saw earlier, but this time our new System Data Source is added. Select the newly added data source and click the **OK** button.

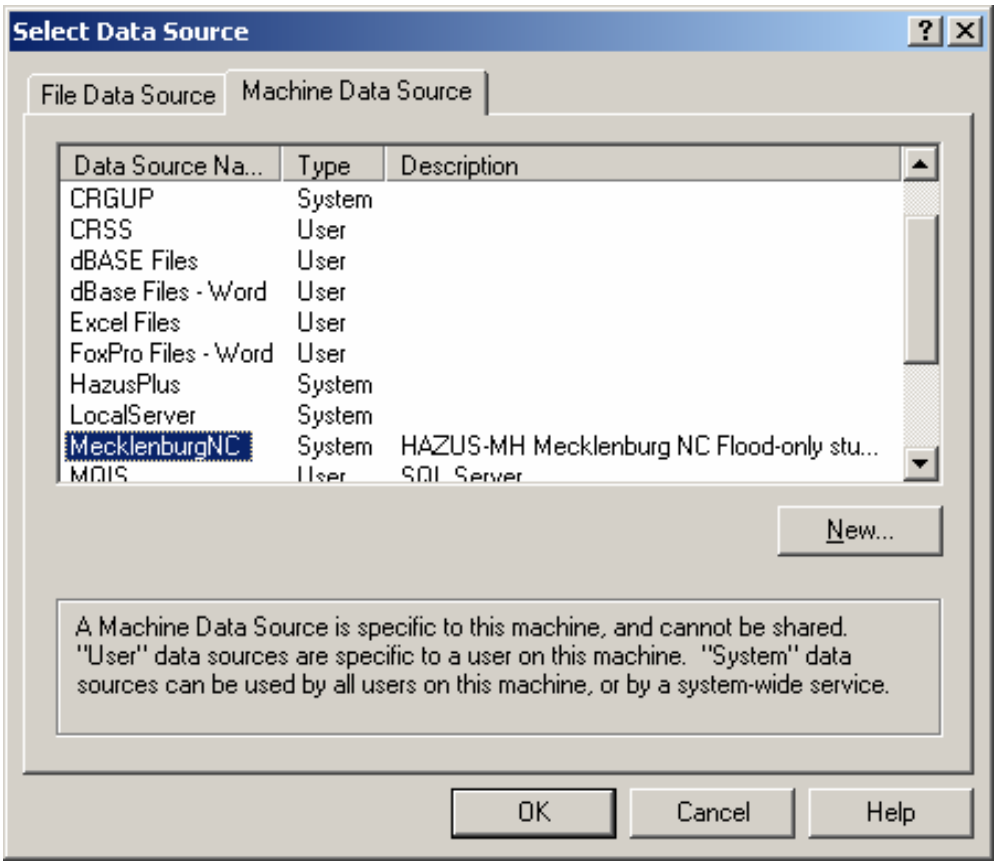


Figure 7.20 ODBC: Select Added Data Source

All of the SQL server tables are now available to be imported. The dialog shows the name of every element in the database.

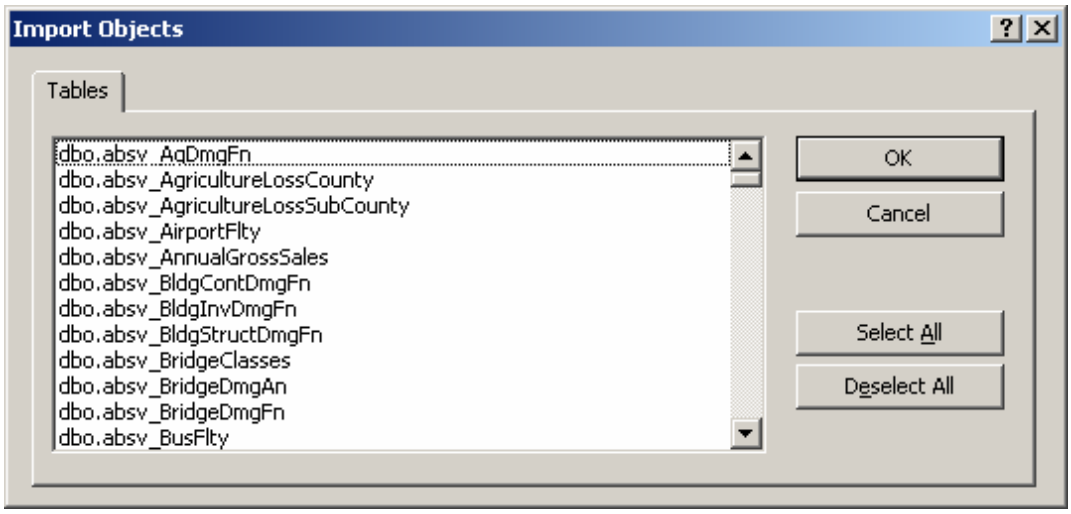


Figure 7.21 ODBC: Import Objects

Here are some notes regarding the nomenclature:

- Common hazard tables have HZ prefix (common to all 3 hazards -- earthquake, flood, hurricane)
- Flood-specific tables have FL prefix (EQ, HU respectively for earthquake, hurricane)
- Flood-specific views have an absv_ prefix. Views are a particular query of the database. Views are what are shown when you view any inventory or results table in HAZUS.
- Flood-specific procedures have ABSP_ prefix (don't import procedures!)
- Flood-specific triggers have ABST_ prefix (don't import triggers!)

In order to import the table or view of interest, you'll need to know its name in the SQL Server database. To determine this, open the inventory or results table of interest in the flood model. In any blank area on the dialog (not on the table itself), use CTRL + SHIFT + left mouse click to see the source table name:

Figure 7.22 ODBC: Source Table Name

In the figure, using CTRL + SHIFT + left click indicates that the active table is a view (ABSV_ prefix) and the name is InvGbsBldgCountOccupGen (inventory general building stock, building count, general occupancy). If you wish to import this table into MS Access, select this name from the Import list. Here are some examples of view (table query) names:

- absv_CareFlty – for medical care facilities
- absv_EmergencyCtr – for emergency centers
- absv_PoliceStation – for police stations
- absv_School – for schools
- absv_UserDefinedFlty – for user defined facilities

Navigate through the flood model to determine the names of the views of interest. Then select those names on the Import list. Click the OK button to import the views to your MS Access database. You now have tables of interest with the field definitions required by the flood model.

Importing flood model SQL Server information through ODBC creates a copy of the data. The default data provided with **HAZUS** is now imported in a local MS-Access database and can now be edited or viewed locally without impacting the data in HAZUS.

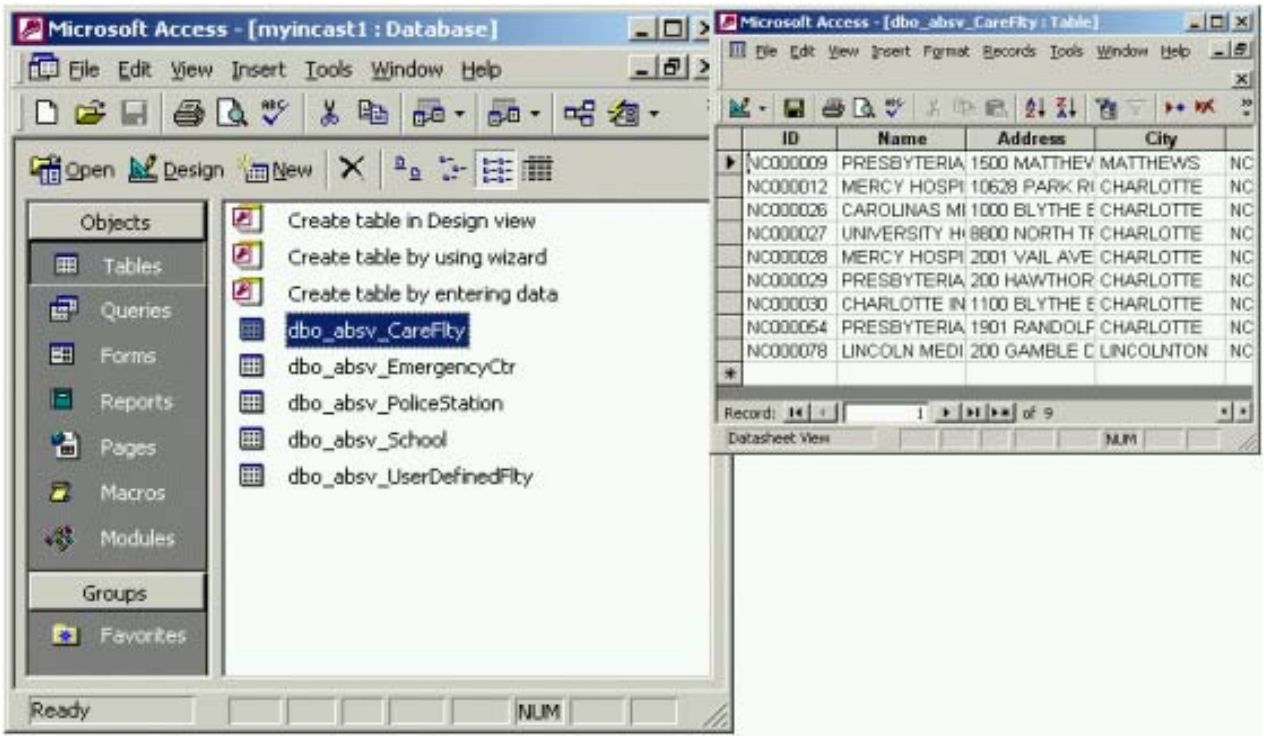


Figure 7.23 ODBC: Import Complete

7.2.3 Import Data File to HAZUS

The user should have a Microsoft Access database containing the data of interest. Begin by opening the inventory table that contains the data. The import functionality allows import to the hz table and associated fl table. For example, for schools data, click on the **Inventory/Essential Facilities** menu item. Click on the **Schools** tab, right-click the mouse button within the table, and select **Import**.

Chapter 8 Building Data Import Tool

The building-data import tool (**BIT**) is a utility that is designed to help you import large databases of property information and to process that data so as to be able to create occupancy to model building type relationships. It can read a variety of different types of database formats and configurations and will translate these into a standard format for use by **HAZUS**. The **BIT** includes a utility that allows you to run queries on databases so that you can identify certain types of properties (e.g. unreinforced masonry) or gather information about buildings with certain characteristics.

8.1 Getting Your Data in the Right Format

Before you run **BIT** you need to ensure that your data is in a form that the program can process. For example, if you have purchased tax assessor's files on magnetic tape, you will have to have those tapes read and transferred to floppy disk or CD-ROM. You will need to convert your database to a Microsoft Access (.mdb) format if it is in some other database format such as *.dbf, *.db, *.xls, etc. Another problem that can occur is that square foot building area is not reported as a single number but instead a sub-area is given for each floor or each portion of the building. In this case you will have to sum the individual sub-areas for each building and put the total building area in a single field. In the case of commercially available property data, you will need to extract the records from the database using software supplied by the vendor. Other problems you may encounter are appearance of properties more than once if they have multiple owners, or the reporting of multi-building complexes, and the use of two or three different occupancy definitions for a single property. All of these will require judgment on your part, and some of these problems will be very challenging.

BIT can only work with the following two types of files:

- Microsoft Access database (*.mdb)
- ASCII text file (*.asc). Any delimiter can be used (comma, tab, etc.)

If your database is not in one of these two formats, you will need to use an external database management program to convert your data into one of these formats.

The **BIT** can only import data from one county at a time. If your data file contains properties from multiple counties, you will need to use a database management program to sort the data by county and organize the data into separate files for each county.

8.2 Starting BIT

BIT can be launched in two ways: either from within **HAZUS** or stand-alone.

To launch **BIT** from within HAZUS, select the command **Inventory|General Building Stock|Building Import Tool (BIT).**

To launch **BIT** independent of **HAZUS**, select **Start|FEMA Risk Assessment System|BIT.** This location assumes that **BIT** was installed in the default group (**FEMA Risk Assessment System)**.

8.3 Specifying the Input File

After starting the **BIT**, you will be presented with the window shown in Figure 8.1. This window guides you through the five steps needed to develop the occupancy to model building type relationships for your region. The first step in the process is to specify the property data file you will be using. To start this step click on the **Specify Input File...** button.

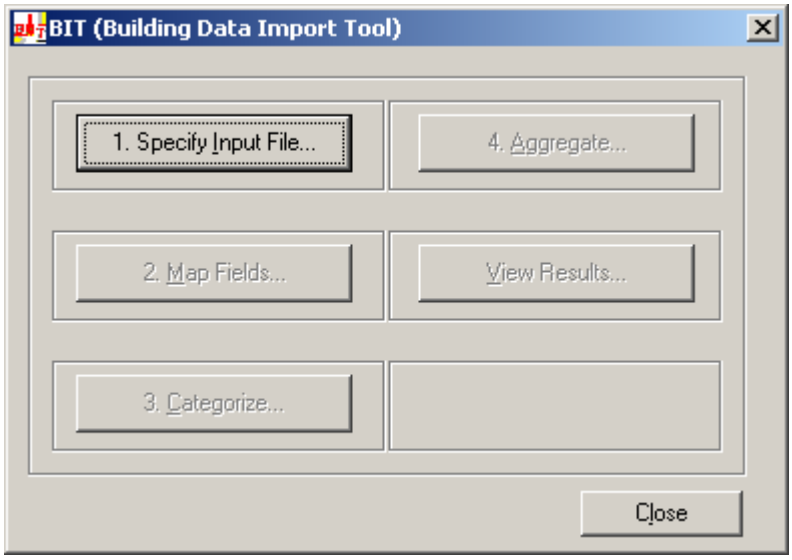


Figure 8.1 Building Data Import Tool Main Menu

You will be asked to select an input file. You can choose from one of the four following options: ASCII text file (*.asc), Microsoft Access Table (*.mdb), configuration file (*.bcf). A configuration file is generated by the **BIT**, and is available only if you have started the import process previously, but did not complete all five steps. The *.bcf file allows you to continue an incomplete import activity without starting over from the beginning.

8.3.1 Importing an ASCII Delimited Database

After you click on the **Specify Input File...** button in Figure 8.1, you will be presented with the window shown in Figure 8.3. Suppose that the particular property data file that you want to import is an ASCII delimited file. A delimited file is one that uses a specific character to separate the fields of information. Delimited files come with a variety of different characters to separate the fields. The most common are the comma and the tab. However, the delimiter can be any character. An example of two records from an ASCII comma-delimited file is shown here:

```
"521-525 Main St","Anytown","94102-1102","121.00","Store
Building",4195,"1",2,"883263",16,"79","","880720","C","Concrete","Stucco","Co
ncrete","Steel","Flat", "Built-up","","Average","$357","","","0284-000"

"332 North St","Anytown","94102-2607","125.00","Apartment",16030,"6",24,
"341314",23,"72","72","830404","C","Concrete","Concrete","Concrete","Concrete
", "Flat","Tar & Gravel","","Fair","$17","","","0333-001"
```

Figure 8.2 Two Records from a Comma-delimited Text File

Each record shown in Figure 8.2 spans three lines and each field is separate by a comma. Quotes are used to indicate alphanumeric (text) data and entries without quotes are numbers. The **BIT** is capable of distinguishing these two types of inputs and it shouldn't cause you any problems when both types appear in the same record. It is important to understand that the **BIT** can recognize this file as ASCII delimited only if you specify the filename extension as .asc.

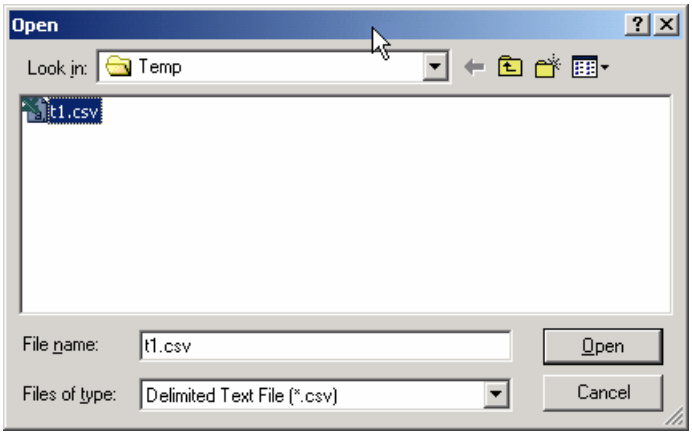


Figure 8.3 Specifying a *.csv Input File in the Building-Data Import (BIT) Tool

After you have specified the file name in Figure 8.3, you will be asked to specify the type of delimiter that is being used as shown in Figure 8.4. If the delimiter is not a comma or a tab, click on **Other** and then type the delimiter in the box to the right. The delimiter can be a single character such as a ' or a ? or a !. At the bottom of the Delimited ASCII Import window is a box entitled **Change default field names**. If you mark this box, you will be presented with the Field Names window shown in Figure 8.5.

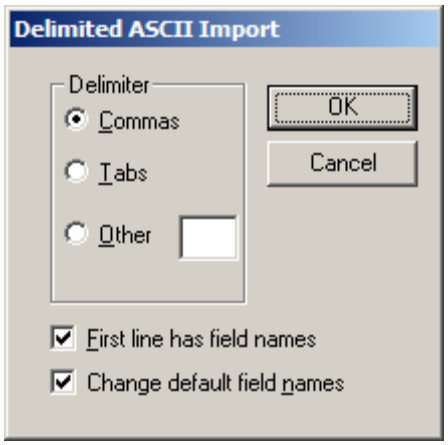


Figure 8.4 Specifying the Delimiters for an ASCII Delimited File

Generally, an ASCII delimited file does not contain embedded field names. Thus when the ASCII delimited file is read by **BIT** the fields will be called Field001, Field002 and so on. The supplier of the data file should have provided you with documentation that indicates what is contained in each field. The Field Names window in Figure 8.5 allows you to rename the fields in your database so that they are easier to keep track of (this window is skipped if the option "Change default filed names" is not checked). To make a change, double click on the field name so that it is highlighted, then type in the new name. When you have changed the desired fields (you do not have to name all fields), click the **OK** button to save the changes. Optionally, you could embed the names of the fields at the first line in the input file and make use of by checking the option "First line has field names".

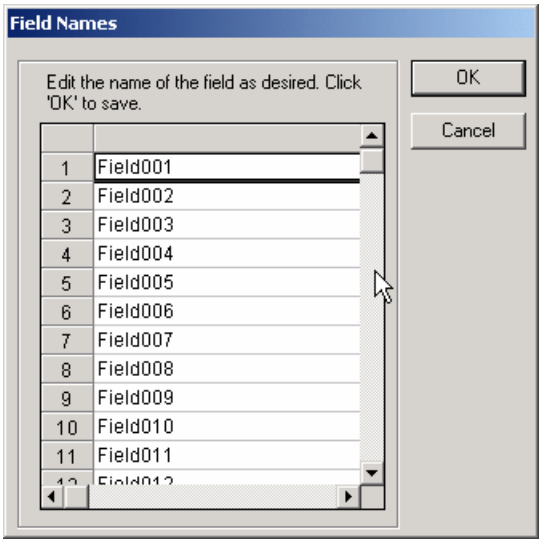


Figure 8.5 Changing the Field Names in an ASCII Delimited File

Once that is specified, the second option is enabled.

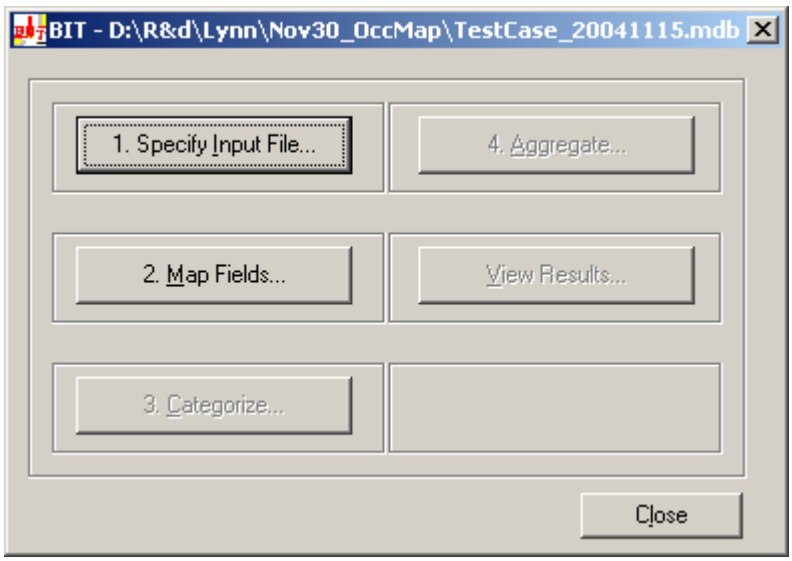


Figure 8.6 Task 2 "Mapping Fields" Enabled

8.3.2 Importing a *.mdb Database

A file that is in an *.mdb format does not require some of the steps that are required for a text file. Simply specify the database file name as shown in Figure 8.7. You will then be presented with a list of tables in the database. Select the desired table to import and click **OK**, and you will be ready for mapping fields (see Section 8.4).

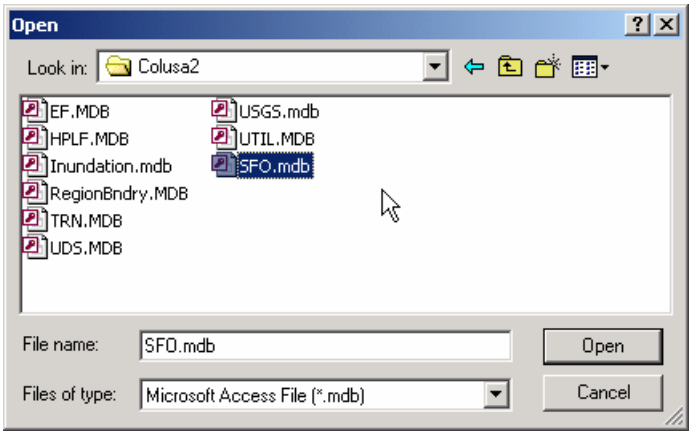


Figure 8.7 Specifying a *.mdb Input File in the Building-Data Import Tool

8.4 Mapping Fields

After having specified the input file, you will need to map the fields in your database (the source) to the fields used in the **HAZUS** database (the target database). The steps for importing data and creating occupancy to model building type relationships must be completed in the numbered

sequence. The labels for steps that are not yet available to you will appear in light gray. To start this step, click on the **Map Fields** button in the main **BIT** menu (see Figure 8.8).

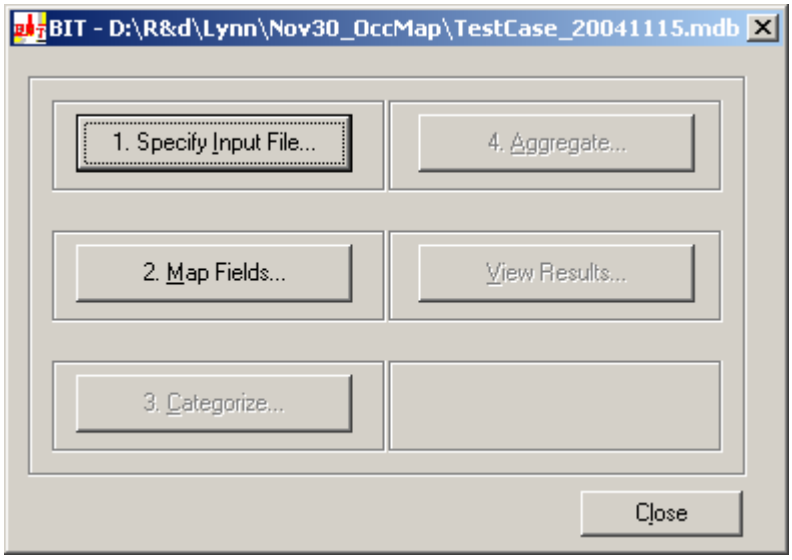


Figure 8.8 Starting the Field Mapping Step from the BIT Main Menu

Since the **BIT** is used to develop occupancy to model building type relationships for your region, the most important information to capture is the occupancy, structural type, square footage and height of your buildings. However, the database you create can have as many fields as you want, allowing you to maintain many types of data. Using the mapping tool outlined in this section, you can be certain that all of the databases you maintain will be in a standard format.

The mapping window shown in Figure 8.9 is used to map the fields in your database (the source) to the fields used in **HAZUS** (the target database). The source-database fields do not have to be in the same order nor do they have to have the same names as the target-database fields. For example, in Figure 8.9 the occupancy types are in the field seventh field ("Field007") in the source database whereas the field that contains this information in the target database is called "Occupancy".

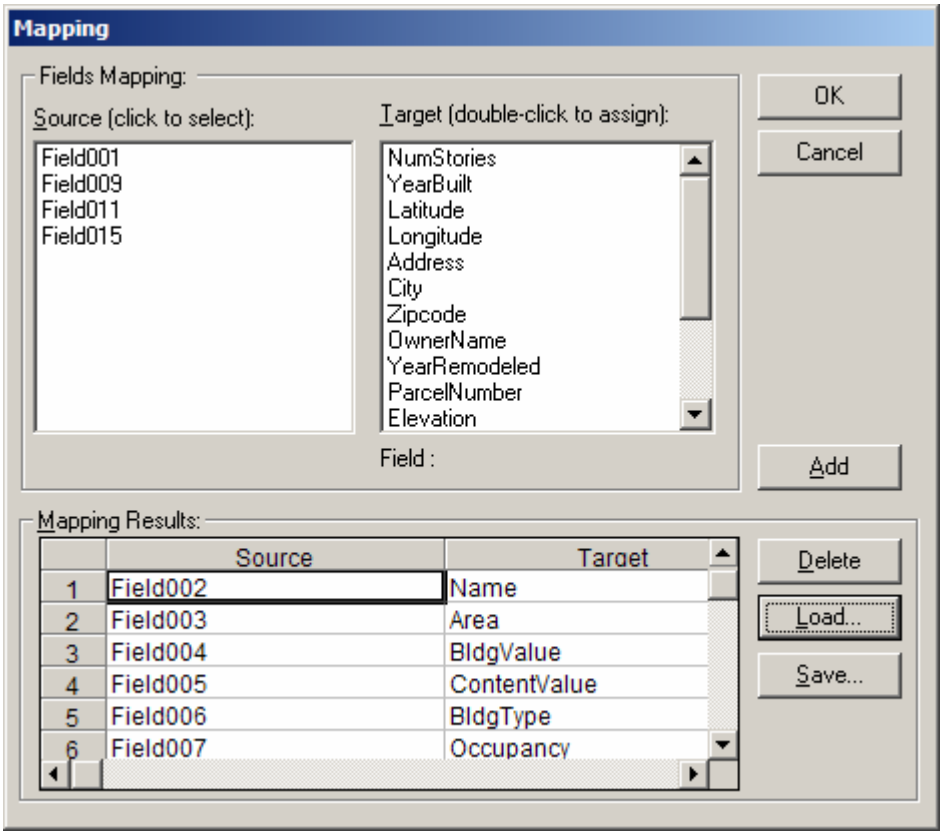


Figure 8.9 Defining a Mapping Scheme from the Source Database to the Target Database in the BIT

To define the desired mapping, simply click on a field name in the source database (e.g. Field004) and the corresponding field name in the target database (e.g. BldgValue) and then click on the **Add** button. After each time you perform this operation the mapping you have defined will appear in the **Mapping Results** box at the bottom of the window. At the same time, these fields will disappear from the **Fields Mapping** box at the top of the window. If you make a mistake, click the **Delete** button and the last mapping pair you have defined will be undone. When you have completed mapping all of the fields, click on the **OK** button, wait a moment, and your database will be reconfigured into the standardized format. At the end of this step a table with the same name as your original file is created in the syBIT database in SQL Server. Your original file will remain unchanged. NOTE: You do not have to map all of the fields from the source database; however, any fields you do not map will not be imported into the target database. There are key fields that must be mapped without which you won't be able to proceed with the mapping. The **BIT** tool will prompt you with the key field (s) that you missed mapping once you try to click the OK button to move on to the next step. An example of this window is shown in Figure 8.10. The window also includes the list of the "must mapped" fields for the **BIT** tool. Table 8.1 lists in detail the required fields and how they are by **BIT.**

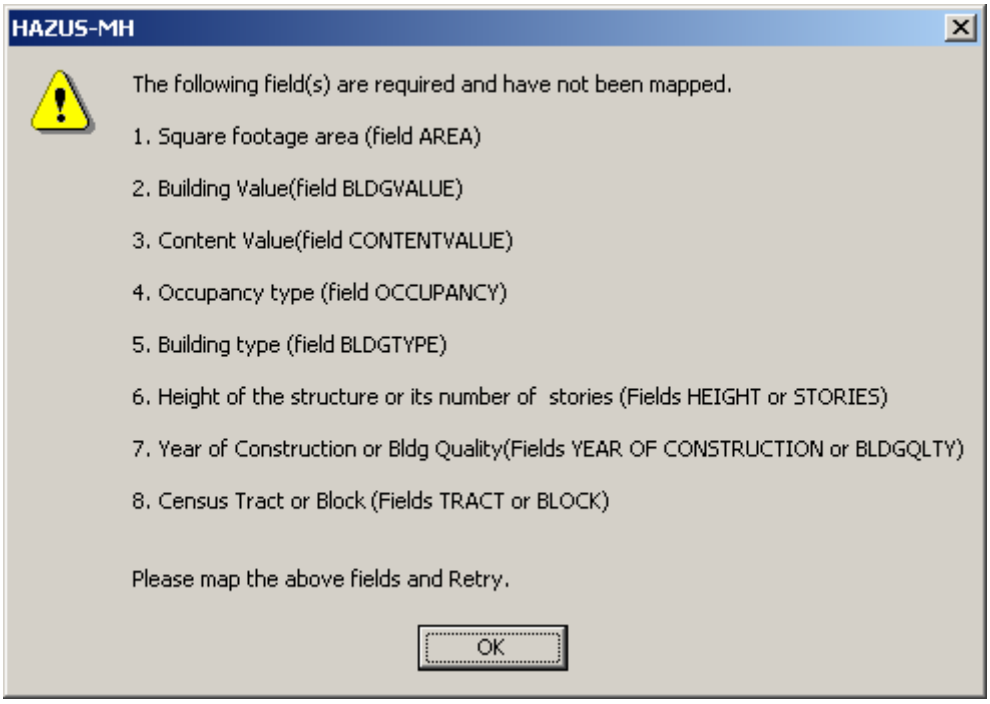

HAZUS-MH
The following field(s) are required and have not been mapped.
1. Square footage area (field AREA)
2. Building Value(field BLDGVALUE)
3. Content Value(field CONTENTVALUE)
4. Occupancy type (field OCCUPANCY)
5. Building type (field BLDGTYPE)
6. Height of the structure or its number of stories (Fields HEIGHT or STORIES)
7. Year of Construction or Bldg Quality(Fields YEAR OF CONSTRUCTION or BLDGQLTY)
8. Census Tract or Block (Fields TRACT or BLOCK)
Please map the above fields and Retry.
OK

Figure 8.10 An Example of a Warning Message in Case You Miss Mapping Key Field(s)

It is possible you have several databases with the same format and you would like to save the mapping that you have just defined. Before you click the **OK** button, click the **Save** button in Figure 8.9. A save window will appear and you will need to enter a name for the saved mapping scheme. Retrieve the saved mapping scheme by clicking on the **Load** button in Figure 8.9.

Design level is used only for the Earthquake model and you can disregard the warning you will receive.

Table 8.1 List of BIT-MH Required Fields

	Field	Field Name in Target Table	Description
1	Area	BldgArea	Built area for building in sq. ft (BIT will adjust the # if not in sq.ft using the conversion factor supplied)
2	Building Value	BldgValue	Current bldg value. Desired unit is in K$ (BIT will adjust the # if not in K$ using the conversion factor supplied)
3	Content Value	ContentValue	Current content value. Desired unit is in K$ (BIT will adjust the # if not in K$ using the conversion factor supplied)
4	Building Type	BldgType	The 'Categorizing' process will translate this to HAZUS specific bldg type.
5	Occupancy Class	Occupancy	The 'Categorizing' process will translate this to HAZUS specific bldg type.
6	Height or # of stories	Height or NumStories	Height (in ft.) if given will converted to # stories to make use of the L, M, or High-rise classification
7	Age or Year of Construction or BldgQuality	BldgQuality	Age/Year of Construction get translated to bldg quality values (C, S, I)
8	Earthquake Design Level	DesignLevel	Optional. If not given, the default for the county will be used.
9	Tract or Block	Tract or Block	Tract is 11-char. Block is 15-char.

8.5 Categorizing Data

The next step in creating standardized data formats is to convert the data to the classification systems of **HAZUS**. For example, your database may use the term "wood" for low-rise wood frame construction whereas this would be classified as a W1 model building type in **HAZUS**. Thus, records with structural type "wood" in the source database need to be converted to "W1" in the target database. To do this step, click on the **Categorize...** button shown in Figure 8.11. At the end of this step a new file will be created. It will have the same name as your original file and a new extension: .TG2. This database is the same as the *.TG1 database except that all of the replacements you have requested have been made.

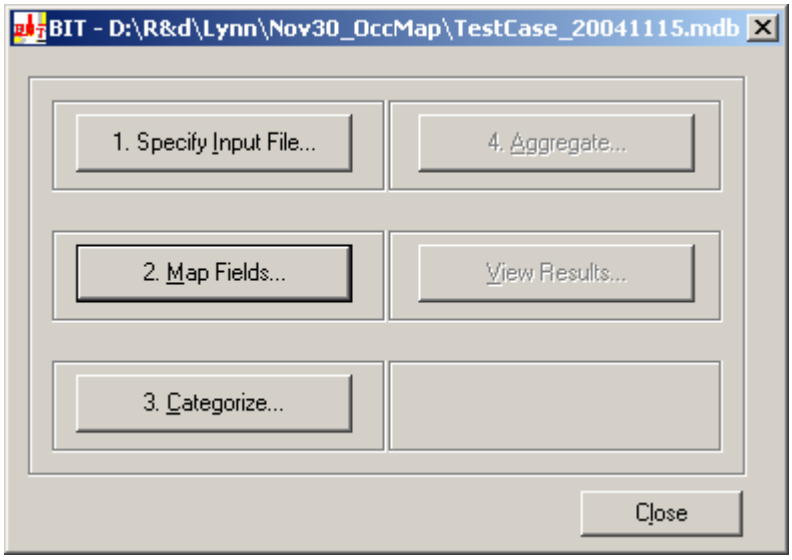


Figure 8.11 Starting the Categorize Function of the BIT

You have the option to select which fields of data you want to categorize (see Figure 8.12). It is likely that none of your data will be in the standardized format and you will want to select the 'Select All' option. To select the items, simply click on them. When you are finished, click the **OK** button.

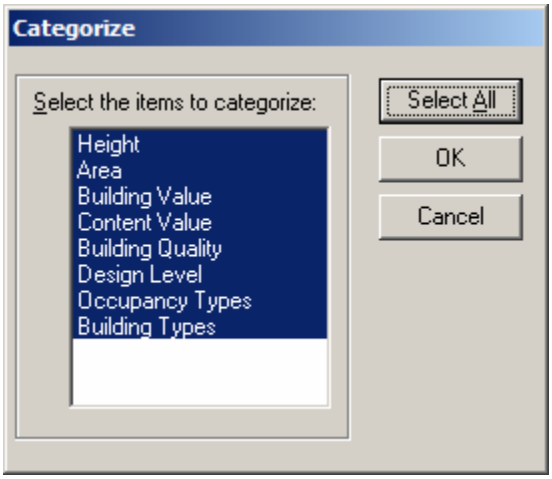


Figure 8.12 Selecting Which Fields you Want to Categorize

8.5.1 Categorizing Number of Stories Data

HAZUS groups of buildings into low, medium and high-rise structures. Thus ultimately, any building with one to three stories height will be classified as low rise. If your database uses numbers to specify the height of the building in feet, the **BIT** will automatically convert the height to low, medium or high-rise. If the building height that you have is in non-feet units, you can use the conversion factor[2] to convert the data to feet. If on the other hand the database that is being used has characters or words for number of stories, then you will need to define a mapping scheme to convert your data to the standardized format. The window in Figure 8.13 is used to indicate which of these situations apply to your data.

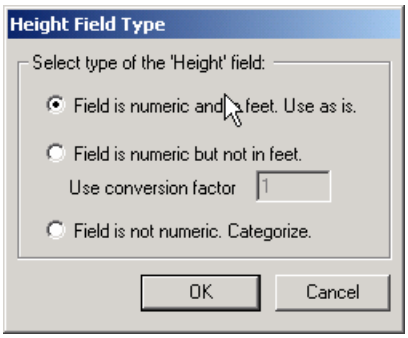

Height Field Type
Select type of the 'Height' field:
Field is numeric and in feet. Use as is.
Field is numeric but not in feet.
Use conversion factor
1
Field is not numeric. Categorize.
OK
Cancel

Figure 8.13 Indicating What Type of Building Story Data You Have

If you click on **Field is non-numeric. Categorize**, then press **OK**, the window in Figure 8.14 is displayed allowing you to define a mapping from your database to the standardized format. As with other mapping windows, after you have defined each mapping, click on the **Add** button and the mapping will appear in the **Results** portion of the window. If you make a mistake, use the **Delete** button.

[2] The conversion factor is used as a **multiplier,** in other words, it takes the original values in the input file, multiplies them by the conversion factor supplied and uses the result.

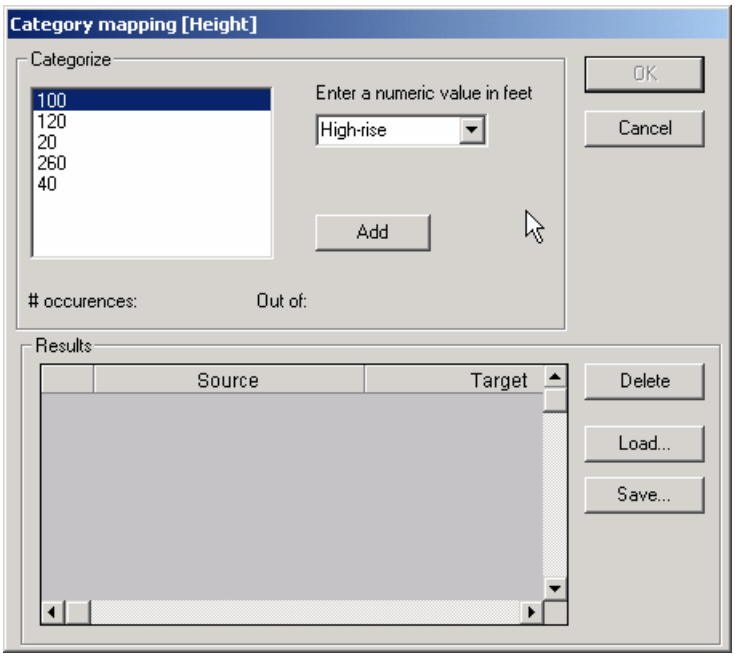


Figure 8.14 Categorizing Number of Stories Data

To save your data mapping scheme, click on the **Save...** button. Use the window shown in Figure 8.19 to name the mapping scheme. A scheme for mapping number of stories will have an .ssl extension, whereas a scheme for mapping building height will have an .hsl extension.

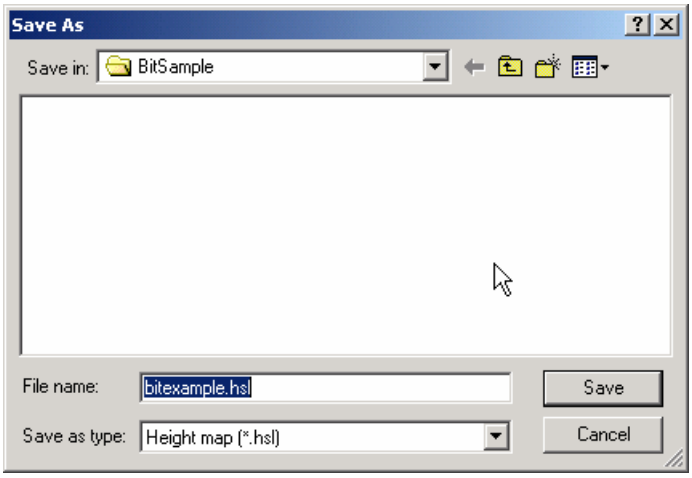


Figure 8.15 Saving Number of Stories Categories

8.5.2 Categorizing Year Built Data

HAZUS lumps buildings into three age groups: pre-1950, 1950-1970 and post-1970. Occupancy to model building type relationships is developed for each of these three groupings. Year-built data is found in a variety of formats in assessor's files and other commercially available property files. It is most common to find the year built expressed in a two-digit format, such as 95, or in a

four-digit format, such as 1995. However, it is possible that other formats could be used such as old, moderate and new. The **BIT** has the flexibility to read any of these formats by selecting the appropriate buttons in Figure 8.16. Perhaps most problematic is how to deal with a zero. A zero can mean that a structure was built in 1900, or in 2000. You may have to ask the supplier of the data how to interpret the occurrence of a zero in the data.

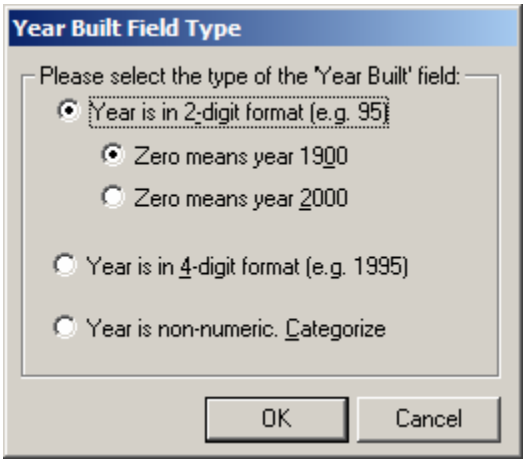

Year Built Field Type
Please select the type of the 'Year Built' field:
Year is in 2-digit format (e.g. 95)
Zero means year 1900
Zero means year 2000
Year is in 4-digit format (e.g. 1995)
Year is non-numeric. Categorize
OK
Cancel

Figure 8.16 Categorizing Year Built Data

8.5.3 Categorizing Occupancy Class Data

In this step you will be required to map the occupancies found in the source database to the standardized occupancies defined in **HAZUS**. All of the 33 specific occupancy classes found in Table A.3 are listed in the **Target** list box found in Figure 8.17. In addition to the specific occupancy classes, you will find five general occupancy classes (Residential, Commercial, Industrial, Government, and Education) and the class "Unknown". General occupancy classes are in all upper-case letters. Some property databases contain very limited information about occupancy; for example, labels such as residential, commercial, and industrial. In this case you will need to use the general occupancy classes for categorizing occupancy.

To define a mapping, click on an occupancy in the **Source** list box and then double click on the corresponding standardized occupancy in the **Target** list box. You can not map multiple occupancies at the same time in the Source list box that corresponds to a single standardized occupancy. This resulted in the four separate mappings found in the **Mapping Results** box. If you find you have made a mistake any time during this process, simply click on the incorrect mapping in the **Mapping Results** box and click on the **Delete** button. Redefine the correct mapping for that occupancy and continue. When you have completed the mapping for all categories in the source database, click the **OK** button.

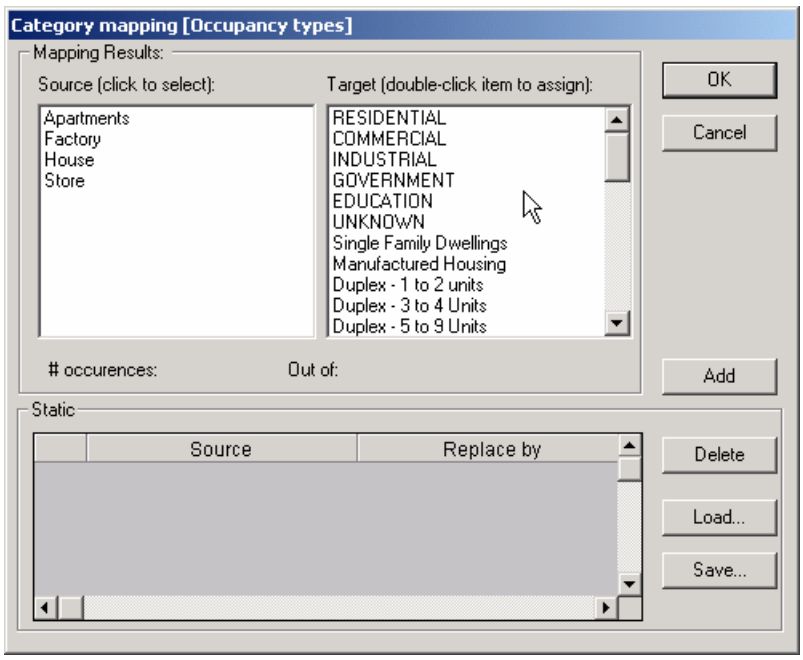


Figure 8.17 Categorizing Occupancy Class Data

Categorizing occupancy class data can be somewhat tricky and can require judgment on your part. Some of the occupancy classes in the property file may not fit perfectly into **HAZUS** classifications. For example, you may find a class such as "Office & Residential" in your database that could be classified as either RES3 "Multi-Family Dwelling" or COM4 "Financial/Professional/Technical Services". You will have to use your judgment in deciding which standardized class best typifies this mixed occupancy. Another problem you may find is that source-database occupancy classes do not always provide a correct description of the property. For example, parking lot, residential lot or vacant lot would imply that these properties have no structures on them. However, in many cases in the sample database used here, there were buildings on these types of properties. You should not be surprised to find that certain occupancies such as universities, institutional housing and government services, to name a few may, be completely absent from your database. As noted in Section 5.1.2, property databases rarely provide detailed information on tax-exempt properties.

As with other mappings defined in the **BIT**, you have the option to save the occupancy class mapping for use on other files. To save the mapping, click on the **Save...** button before clicking **OK**. The occupancy mapping file will be saved with an .osl extension as shown in Figure 8.18. To use the mapping in the future, click on the **Load...** button in Figure 8.17.

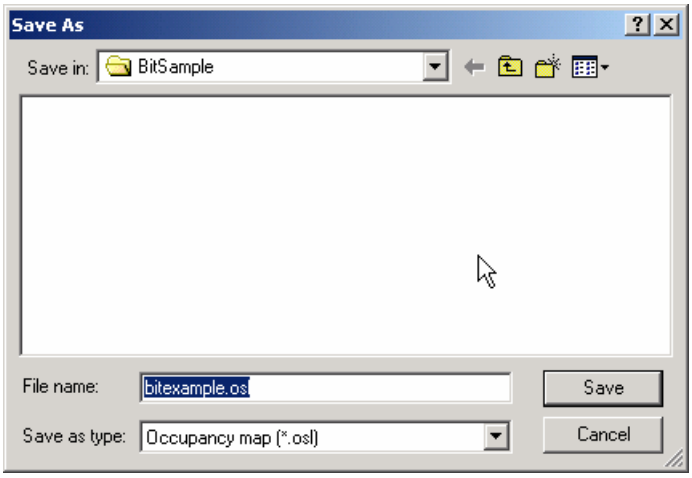


Figure 8.18 Saving an Occupancy Mapping Scheme

8.5.4 Categorizing Building Type Data

In this step you will be required to map the structural types found in the source database to the model building types defined in **HAZUS** (See Appendix B, Table B.2). The 16 general building types found in Table B.2 are listed in the **Target** list box shown in Figure 8.19. In addition to the general model building types, you will find four basic building material types (Wood, Steel, Concrete, and Masonry) and the class "Unknown". Basic building material types are in all upper-case letters. Many property databases contain very limited information about the structural system used, and the categories used are often based on fire safety information. For example, in this sample database shown in Figure 8.19, category C contains brick, tilt-up and formed concrete construction. The user has chosen to map category C to masonry. Clearly, this will introduce uncertainty into the occupancy to model building type relationships that are produced by the **BIT**. It is rare to find a property database that provides sufficient information to define reliable mappings to all general building types.

To define a mapping, click on a building type in the **Source** list box and then double-click on the corresponding standardized building type in the **Target** list box. You can not map multiple building types at the same time in the **Source** list box that correspond to a single standardized building type. If you find you have made a mistake any time during this process, simply click on the incorrect mapping in the **Mapping Results** box and click on the **Delete** button. Redefine the correct mapping for that building type and continue.

When you have completed the mapping for all categories in the source database, click the **OK** button. At this point the **BIT** will check if the Design Level was mapped at the field mappings or not if not it will go to Step 8.5.5 else it will go to step 8.6.6.

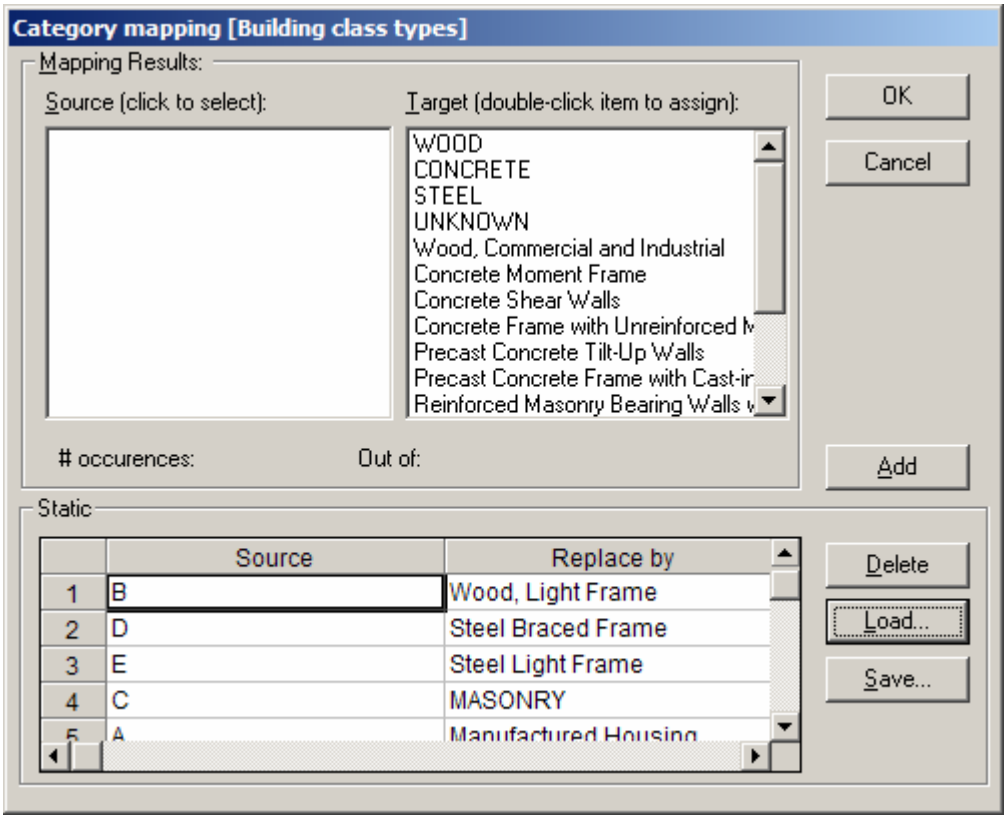


Figure 8.19 Categorizing Building Type Data

As with other mappings defined in the **BIT**, you have the option to save the building type mapping for use on other files. To save the mapping, click on the **Save...** button before clicking **OK**. The building type mapping file will be saved with a .bsl extension as shown in Figure 8.20. To use the mapping in the future, click on the **Load...** button in Figure 8.19.

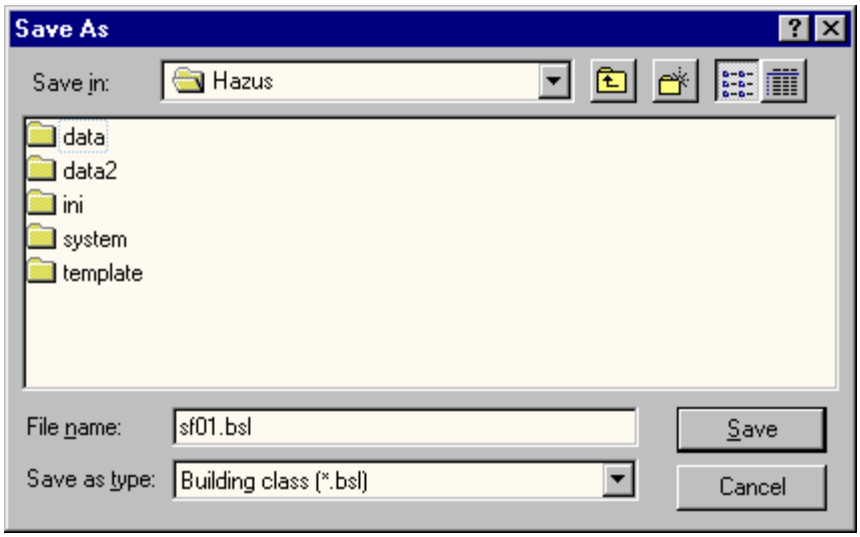


Figure 8.20 Saving a Building Type Mapping Scheme

8.5.5 Categorizing Design Level (Optional)

This step is required if you have not specified the Design Level Field mapping. In this step you will be required to map the design level found in the source database to the design level defined in **HAZUS.** There are 3 types of design levels defined in **HAZUS** low, medium and high as shown in Figure 8.21.

To define a design level, click on a design level in the **Source** list box and then double-click on the corresponding design level in the **Target** list box. You can not map multiple design levels at the same from the design levels in the **Source** list box that correspond to a single design level. If you find you have made a mistake any time during this process, simply click on the incorrect mapping in the **Mapping Results** box and click on the **Delete** button. Redefine the correct mapping for that design level and continue.

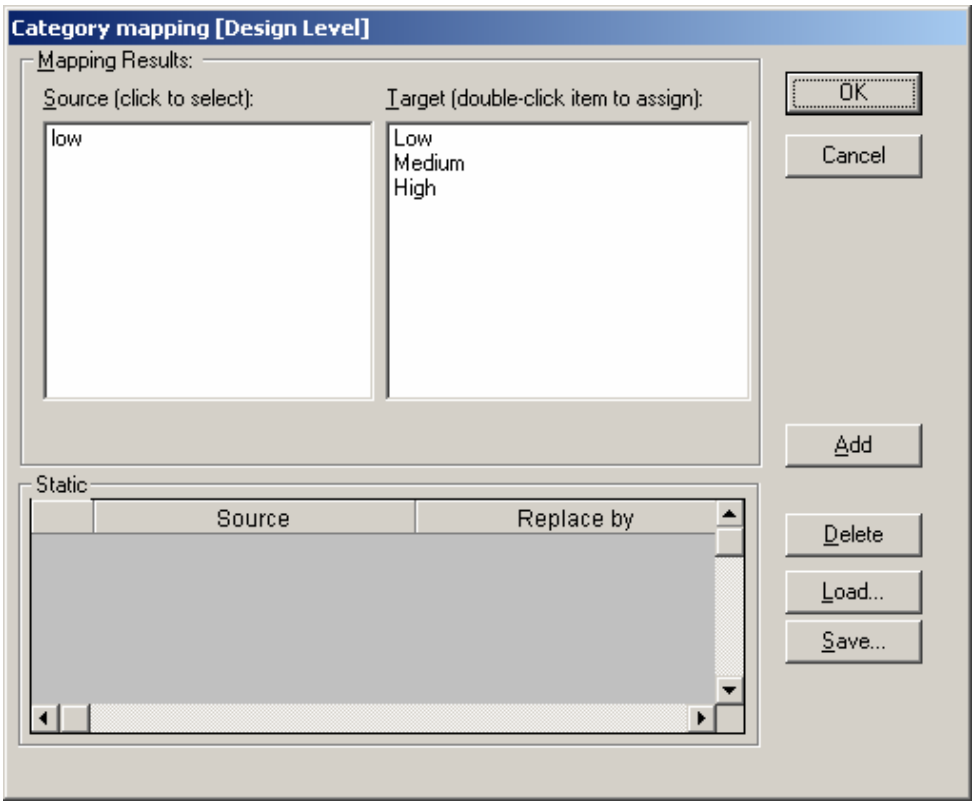


Figure 8.21 Categorizing Design Level

As with other mappings defined in the **BIT**, you have the option to save the design level mapping for use on other files. To save the mapping, click on the **Save...** button before clicking **OK**. The design level mapping file will be saved with a .dsl extension as shown in Figure 8.22. To use the mapping in the future, click on the **Load...** button in Figure 8.21.

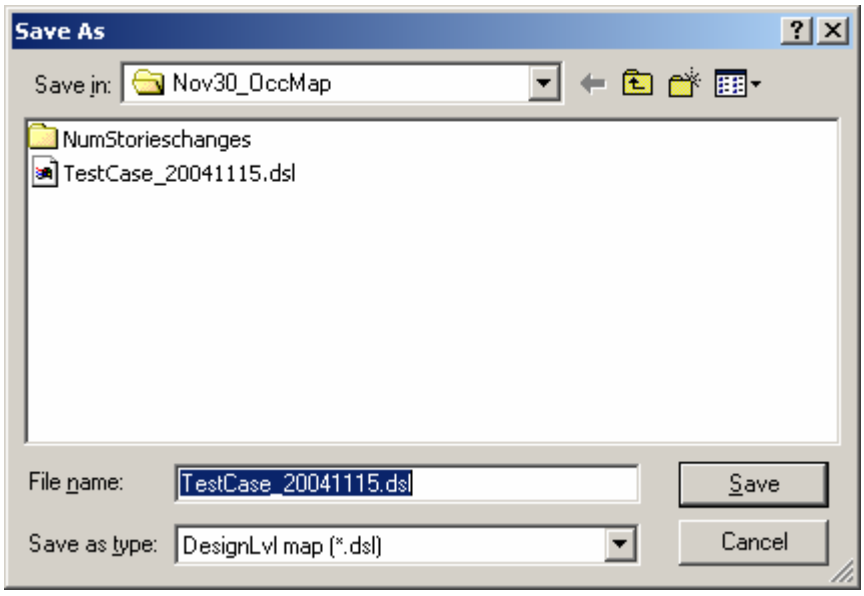


Figure 8.22 Saving a Design Level Type Mapping

When you have completed the mapping for all categories in the source database, click the **OK** button.

8.5.6 Categorizing Floor Area

HAZUS uses Area in thousands of square feet. However, it is possible the field is numeric but not in the thousands of square feet. You can use a conversion factor as shown in Figure 8.23.

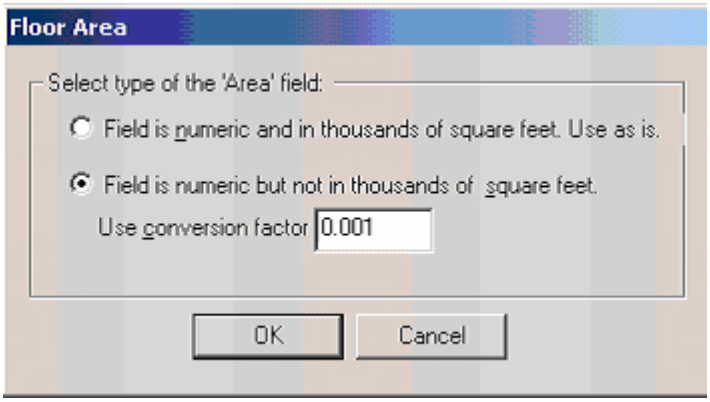

Floor Area
Select type of the 'Area' field:
Field is numeric and in thousands of square feet. Use as is.
Field is numeric but not in thousands of square feet.
Use conversion factor
0.001
OK
Cancel

Figure 8.23 Categorizing Floor Area Data

When you have defined the type, click the **OK** button.

8.5.7 Categorizing Building Value

HAZUS uses building values in thousands of dollars. However, it is possible field is numeric but not in the thousands of dollars. You can use a conversion factor as shown in Figure 8.24.

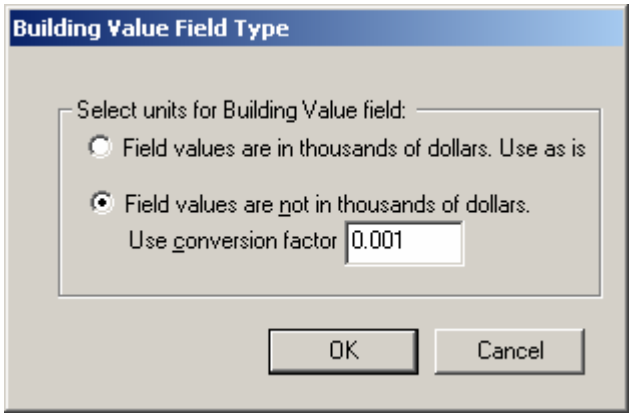

Building Value Field Type
Select units for Building Value field:
Field values are in thousands of dollars. Use as is
Field values are not in thousands of dollars.
Use conversion factor
0.001
OK
Cancel

Figure 8.24 Categorizing Building Value Data

When you have defined the type, click the OK button.

8.5.8 Categorizing Content Values

HAZUS uses Content Values in thousands of dollars. However, it is possible field is numeric but not in the thousands of dollars. You can use a conversion factor as shown in Figure 8.25.

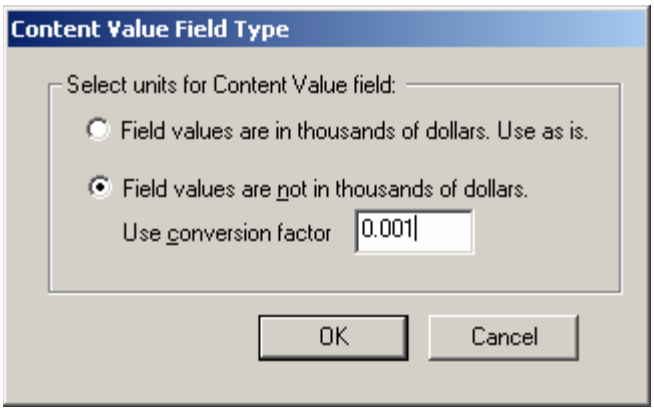

Content Value Field Type
Select units for Content Value field:
Field values are in thousands of dollars. Use as is.
Field values are not in thousands of dollars.
Use conversion factor
0.001
OK
Cancel

Figure 8.25 Categorizing Content Values Data

When you have defined the type, click the OK button.

At this point the BIT will substitute the standardized categories for the original categories in the source database. Depending on the size of the database this will take a few minutes to more than an hour.

8.6 Aggregating the Database Statistics

At this point the **BIT** is ready to create the occupancy to model building type relationships for each census tract. Click on the **Aggregate** button (shown in Figure 8.26) and wait. When the aggregation is done you will be able to view the results using the **View Results** button.

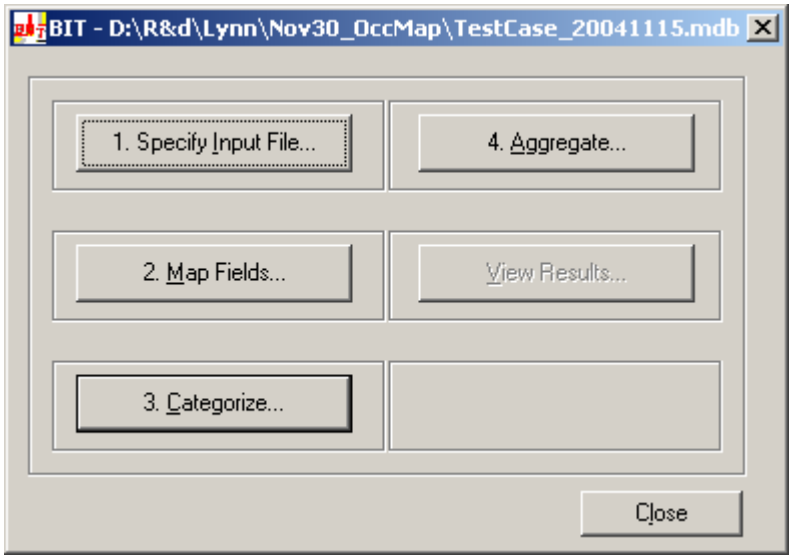


Figure 8.26 Starting the Aggregation Utility

If for some reason you have changed your database in some way and need to run the aggregate utility again, you will execute the exact same steps and BIT will update the data automatically.

8.7 BIT-MH Results

Once the aggregation process has finished, BIT-MH would have created the following type of results:

- Square footage values by specific occupancy
- Building structural and content dollar exposure values by specific occupancy
- Building count values by specific occupancy
- General mapping schemes (specific building type vs. general occupancy)
- Mapping scheme distribution matrices applicable to the earthquake module (specific building type vs. specific occupancy)

All of the above can then be imported into **HAZUS** to replace the default data. To get guidance on the process, contact Technical Support.

Chapter 9 Overview of the Flood Information Tool (FIT) Process

The Flood Information Tool (FIT) is an ArcGIS extension designed to process user-supplied flood hazard data into the format required by **HAZUS** Flood Model. The FIT, when given user-supplied inputs (e.g., ground elevations, flood elevations, and floodplain boundary information), computes the extent, depth and elevation of flooding for riverine and coastal hazards. The information below is a brief overview of the riverine and coastal methodologies. For more detailed information, please refer to the Flood Information Tool (FIT) User Manual.

9.1 Riverine Methodology

9.1.1 Input Floodplain Boundary

The user is required to identify up- and downstream limits of study and the feature class field(s) that contains the elevation data in the polyline feature class. If the floodplains are represented by more than one polygon, the user is required to identify the polygon associated with the study area. The floodplain boundary polygon need not be associated with any particular flood. It is used by the FIT only to define a "smooth" line representing the general flow path of floodwater. Only one polygon can be associated with a study reach. Floodplains that are disconnected (by a road crossing, for example) must be somehow connected (merged) or studied as two reaches.

9.1.2 Centerline of Flow

Once the stream limits have been chosen, the program will define a polyline from the upstream limit to the downstream limit. That polyline is, in a sense, the centerline of the floodplain. It is the aforementioned smooth line representing the general flow path of floodwater. Note that the program uses the centerline to identify cross sections within the reach. Specifically, only cross section lines that cross the centerline are considered in subsequent analyses. It is important to ensure that all cross sections within a reach cross the centerline. Note that lines that cross the floodplain polygon necessarily cross the centerline.

9.1.3 Bounding Polygon

An initial buffer is computed around the centerline and the user is prompted to increase and/or decrease the buffer until satisfied that the conveyance area of the floodplain of interest is contained within the buffer. The chosen buffer defines the extent to which flood depths will be calculated and, therefore, is referred to as the bounding polygon. The extent of the floodplain boundary feature class may help in guiding the decision on how large to make the bounding polygon.

The lengths of the cross section lines and the limits do not restrict the size of bounding polygon. If necessary, the program will extend cross-section lines to the bounding polygon. If necessary, the cross-section lines are extended in a manner that preserves a sense of alignment

perpendicular to flood flow. The limits are extended in a straight line following the alignment at the ends of each respective limit. Users should try to avoid drawing stream limits that cross each other, intersect cross sections, or otherwise cut off portions of the bounding polygon pertinent to describing the floodplain.

9.1.4 Non-Conveyance Areas

Certain low-lying areas adjacent to the floodplain, such as tributary streams, that do not convey but, rather, retain floodwater (pond) at the flood elevation in the conveyance part of the floodplain, need not be included within the bounding polygon. The FIT provides an analysis option for including such areas inside and outside of the bounding polygon. The ideal bounding polygon contains all portions of (different frequency) floodplains being analyzed and, also, minimizes the areas subject to ponding.

9.1.5 Interpolation of Additional Hazard Grids

If the cross sections are attributed with multiple flood elevations, the FIT uses the information supplied for the initial analyses to develop subsequent flood depth grids. That is, subsequent flood depth grids can be developed without re-entering reach limits and choosing bounding polygons. If cross sections are attributed with at least three flood elevations and corresponding discharge values, the FIT offers an option to interpolate other flood depth grids.

9.1.6 Modeling Tips

The study reach is defined by the choice of up- and downstream limits. In some situations, subdividing a reach into shorter reaches can improve the efficiency (run time) of the FIT. Subdividing a reach into reaches covered by bounding polygons of different sizes will yield results quicker than using the largest bounding polygon for the entire reach. In general, reaches should be chosen to include relatively homogeneous floodplain widths. Reaches should overlap enough to ensure that there are no gaps in coverage of the floodplain.

Highly meandering floodplain configurations may warrant special attention. If the flow centerline (not the stream) has a horseshoe-shaped meander, increasing the buffer will, at some distance, create a discontinuity in the bounding polygon. An “island” will form within the bounding polygon somewhere within the meander (inside the horseshoe). The interpolation algorithm in the FIT does not operate properly in such situations. Increasing the bounding polygon beyond that limiting size will result in error messages. If the bounding polygon must be increased beyond that limit, the meander should be analyzed piece-wise, thereby removing the “horseshoe” shape within any reach.

9.2 Coastal Methodology

9.2.1 Shoreline Characterization

The user is required to identify all coastal flood sources that will be considered by **HAZUS**, and to draw a shoreline associated with each flood source. The shoreline drawn by the user should

be a general depiction of the shoreline, and should not be a detailed rendering. In tidal areas, the shoreline drawn should represent the approximate mean sea level shoreline; in the Great Lakes the shoreline should be drawn at approximately the International Great Lakes Datum (IGLD) chart datum. If the user has a local map layers depicting the water line, this can be used as a guide when drawing the generalized shoreline.

The user must then divide each shoreline into segments of common physical characteristics and wave exposure. The shoreline types available for user selection include: rocky bluff; sandy bluff, little beach; sandy beach, small dune; sandy beach, large dune; open wetland; erosion protection structure. If the user selects an erosion protection structure (e.g., seawall or revetment) for a shoreline segment, the user must assign a level of protection afforded by the structure (i.e., a flood return period, below which the structure will not fail, and below which the structure will protect the uplands from flooding and erosion).

The user must provide the 100-year stillwater elevation at each shoreline segment, along with any contribution from wave setup (the stillwater elevation and wave setup information are published by FEMA in the Flood Insurance Study report -- FIS-- for each coastal community). The FIT relies upon the 100-year stillwater elevation (without setup) to calculate 10-year, 50-year and 500-year stillwater elevations. The user can edit or replace these elevations with values taken directly from the FIS, if available; otherwise, the FIT will use the calculated values, which are based on nationwide default data. Ultimately, the FIT can use the stillwater elevation values -- calculated or input by the user – to calculate 10-year, 50-year, 500-year and interpolated flood elevation grids.

The FIT relies upon the user segmentation to differentiate between those segments that will be subject to flood-induced erosion and those that won't. The FIT will generate shore-perpendicular transects from each shoreline segment. The transects are located at a pre-determined spacing and extend inland from the shoreline. The user is free to add and delete new transects if so desired.

9.2.2 Frontal Dune Erosion

The FIT will create a profile (of ground elevation versus distance inland from the shoreline) for each transect crossing an erodible shoreline segment, and with sufficient wave action to cause erosion of dunes and bluffs or failure of erosion protection devices during the base flood. The user may select the peak and toe of the dune/bluff, or accept the FIT selections. The FIT will then calculate an eroded ground profile along each transect, and interpolate an eroded ground elevation grid.

9.2.3 Output Hazard Grids

The FIT will calculate the flood depth grid (i.e., the difference between the flood elevation grid and the eroded ground elevation grid) for the 100-year flood and for other return periods selected by the user. This information will be passed to **HAZUS**, along with other data (shoreline characteristics, transect data, stillwater elevations, flood hazard zone information, etc.). **HAZUS** will use the flood depth grids created by the FIT with a suite of flood depth-damage functions to calculate flood damage. The vertical erosion grid calculated by the FIT (i.e., the vertical

difference between the original ground elevation grid and the eroded ground elevation grid) will also be passed to **HAZUS**, for use with an erosion depth-damage function to calculate erosion damage.

Chapter 10 Running HAZUS Flood with User Supplied Data

This chapter provides a step-by-step discussion of how to perform an analysis if you wish to modify the hazard definition, default analysis parameters, or analysis options. Before attempting an analysis that will incorporate user-supplied data, follow the steps in Chapter 3 for running an analysis using only default data.

10.1 Defining the Study Region

The first step in any analysis is defining a study region. Please refer to Section 3.1 for a complete description of this process.

10.2 Defining the Inventory Data

The second step is to review the inventory data and modify the data, as necessary. Please refer to Chapter 4 through Chapter 8 for information on how to define the inventory data.

10.3 Defining the Hazard

In order to apply user-supplied flood hazard data to the Flood Model, use of the Flood Information Tool (FIT) is required. The FIT was discussed previously in Section 4.2 and Section 9. For detailed information, please refer to the *FIT User Manual*. To import FIT results to **HAZUS**, click on the **Hazard/User Data** menu item. Select the appropriate FIT hazard (riverine or coastal) and use the resulting dialog (Figure 10.1) to browse to the FIT project folder on disk.

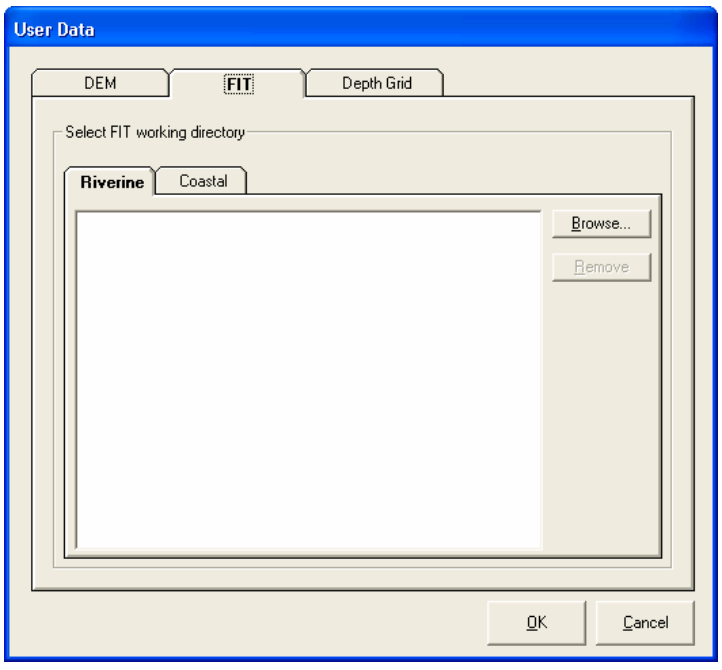


Figure 10.1 FIT Working Directory Selection

Click OK when finished and the FIT project data are imported to **HAZUS**. Continue with other hazard menu items, and upon reaching the **Hazard/Scenario New** dialog, select FIT polygons of interest using the select tool. The selected FIT data will be used in the hazard computation.

10.4 Damage Functions

The flood model default data includes over 700 depth-damage functions that relate water depth to structure and content percent damage. The Damage Functions includes Buildings, Essential Facilities, Transportation Systems, Utility Systems, Agricultural Products, and Vehicles. All of these damage functions are very similar with the exception of the Agricultural Products. An example of a Damage Function can be viewed from the **Analysis/Damage Functions/Buildings** menu item (Figure 10-2). The functions can be viewed by hazard type and general occupancy.

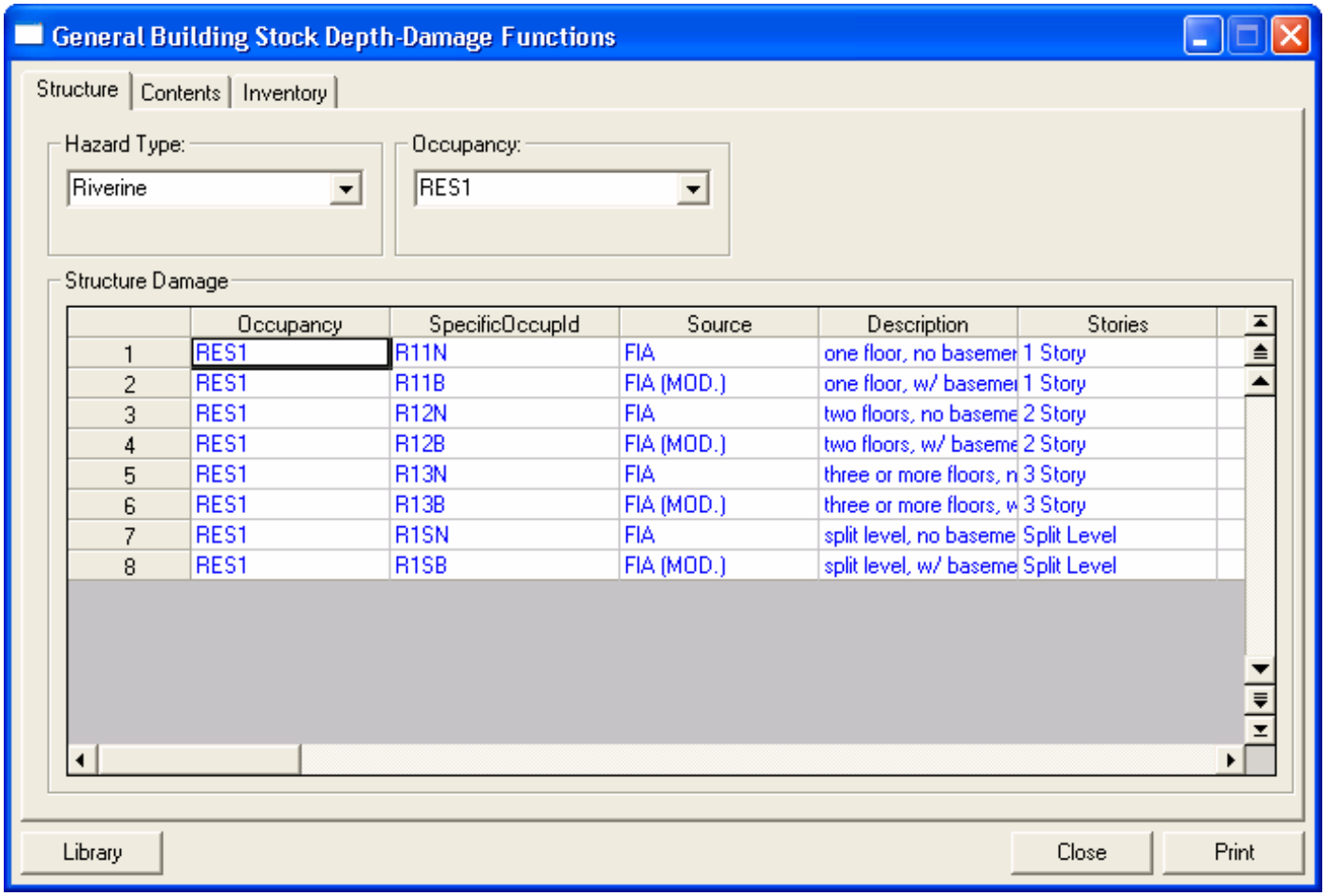

General Building Stock Depth-Damage Functions
Structure
Contents
Inventory
Hazard Type:
Riverine
Occupancy:
RES1
Structure Damage
Occupancy
SpecificOccupId
Source
Description
Stories
1 RES1 R11N FIA one floor, no basemer 1 Story
2 RES1 R11B FIA (MOD.) one floor, w/ basemer 1 Story
3 RES1 R12N FIA two floors, no baseme 2 Story
4 RES1 R12B FIA (MOD.) two floors, w/ baseme 2 Story
5 RES1 R13N FIA three or more floors, n 3 Story
6 RES1 R13B FIA (MOD.) three or more floors, w 3 Story
7 RES1 R1SN FIA split level, no baseme Split Level
8 RES1 R1SB FIA (MOD.) split level, w/ baseme Split Level
Library
Close
Print

Figure 10.2 Building Damage Functions

To apply a user-defined damage function, click on the Library button on the bottom left hand corner of the dialog. The resulting dialog displays available damage functions for the selected specific occupancy (Figure 10.3).

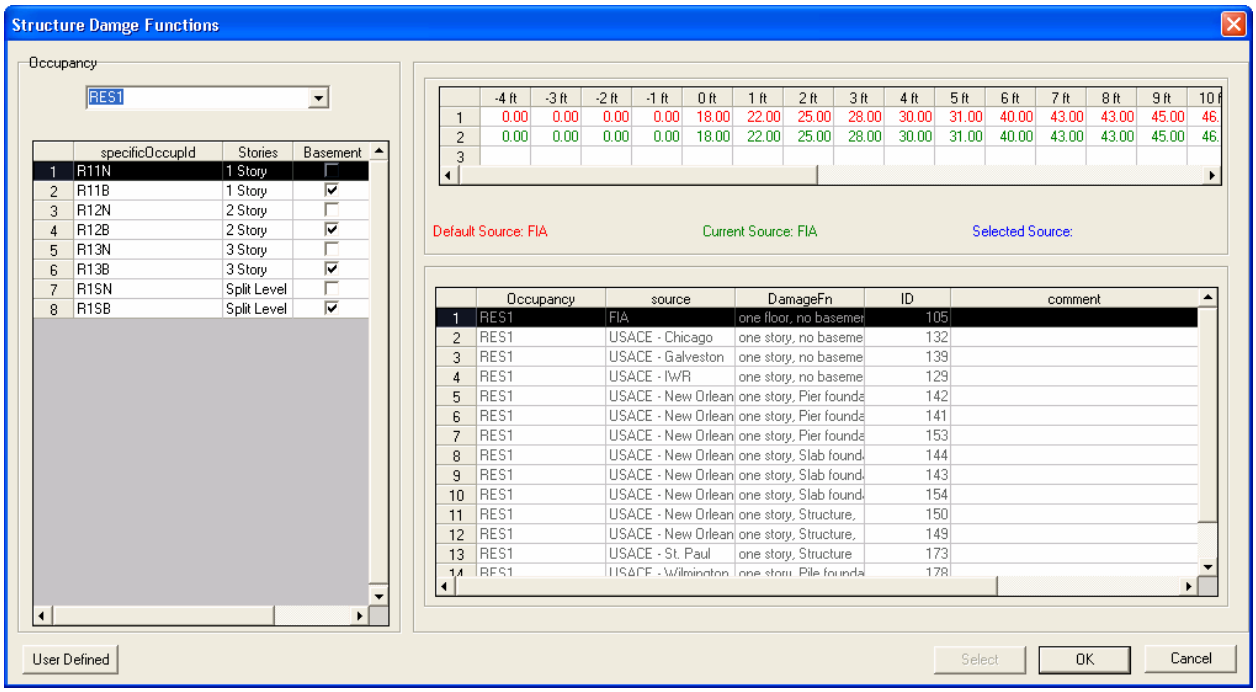
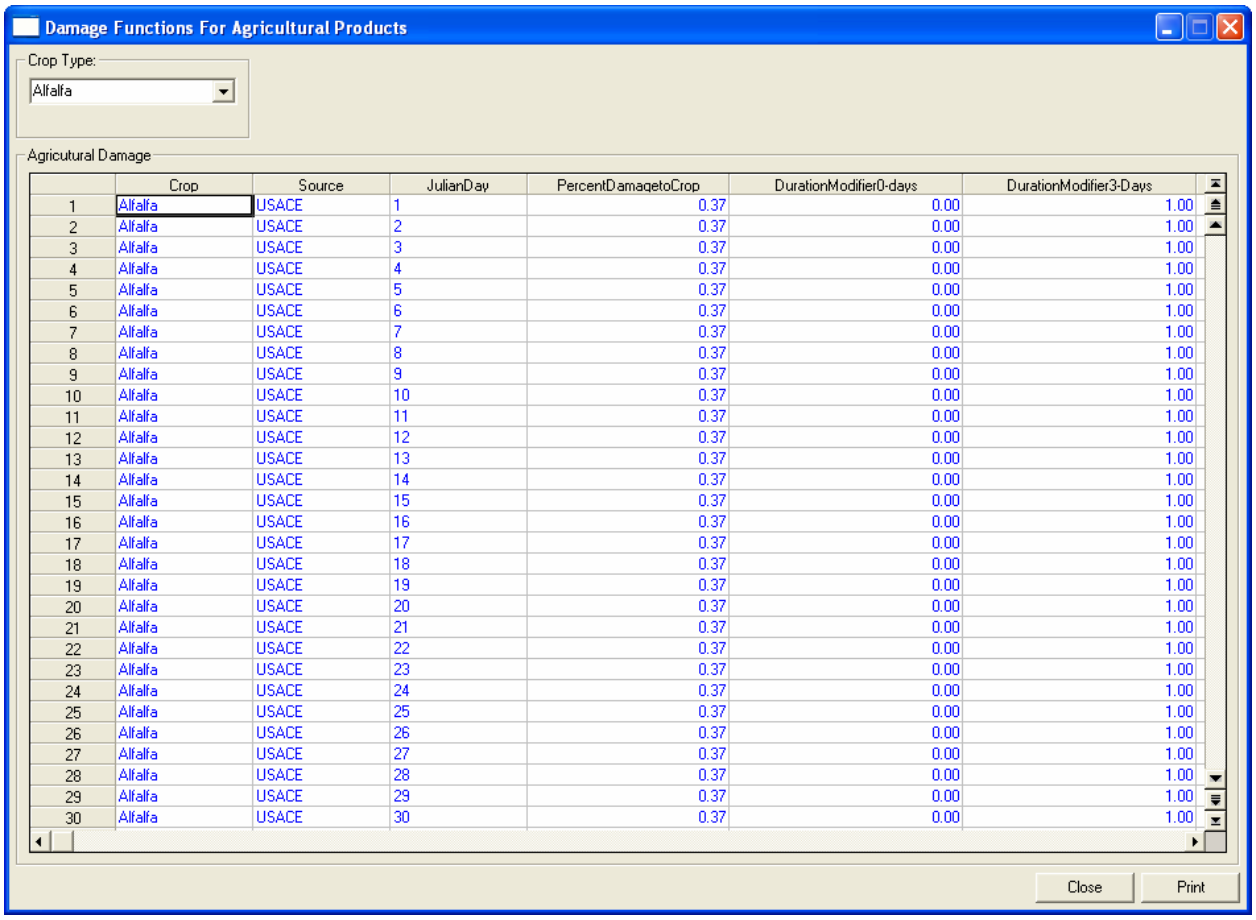


Figure 10.3 Damage Functions by Specific Occupancy

Click on the *User Defined* button in the dialog's bottom left hand corner to add a new damage function for the indicated specific occupancy. An example of the Damage Function for Agricultural Products can be seen in Figure 10.4.



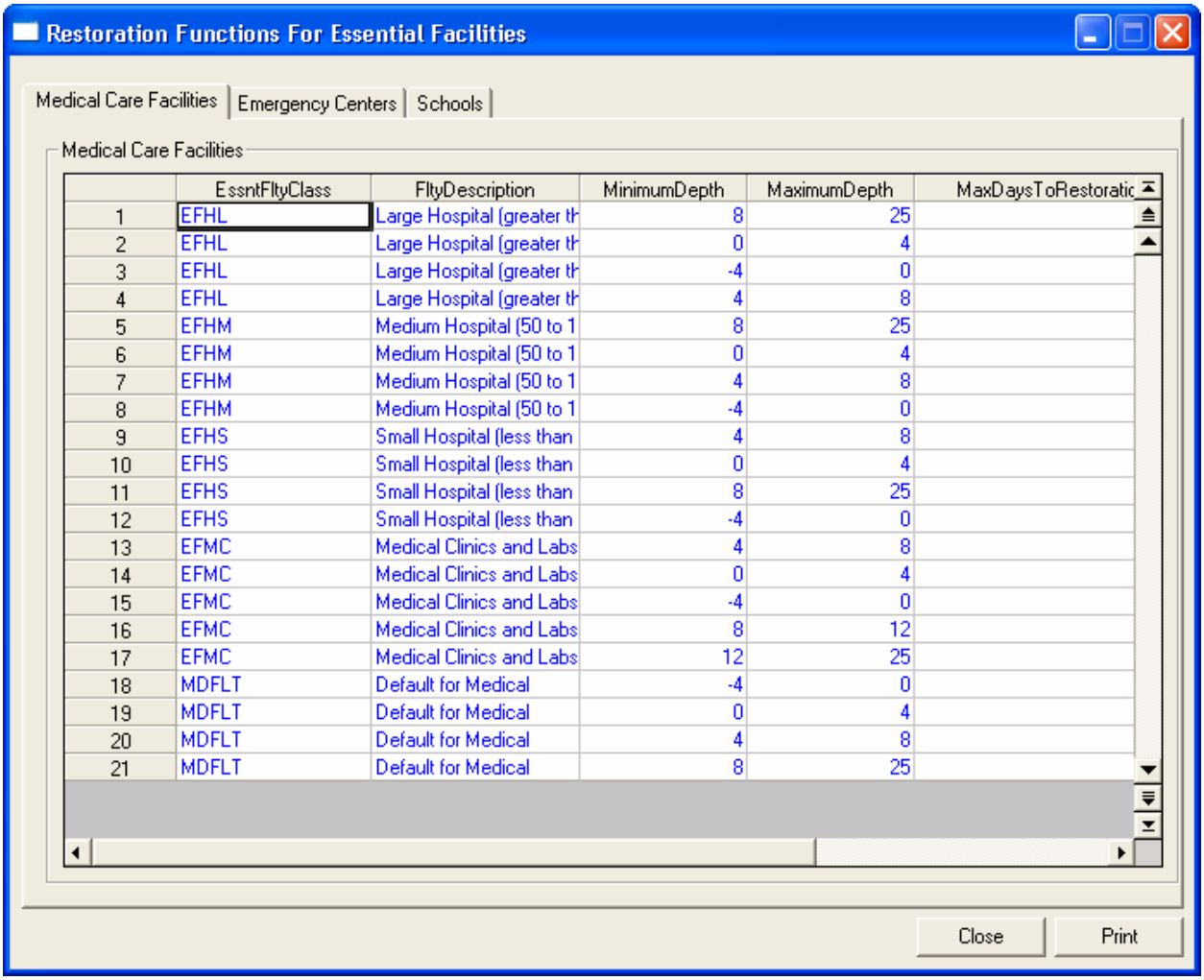
	Crop	Source	JulianDay	PercentDamagetoCrop	DurationModifier0-days	DurationModifier3-Days
1	Alfalfa	USACE	1	0.37	0.00	1.00
2	Alfalfa	USACE	2	0.37	0.00	1.00
3	Alfalfa	USACE	3	0.37	0.00	1.00
4	Alfalfa	USACE	4	0.37	0.00	1.00
5	Alfalfa	USACE	5	0.37	0.00	1.00
6	Alfalfa	USACE	6	0.37	0.00	1.00
7	Alfalfa	USACE	7	0.37	0.00	1.00
8	Alfalfa	USACE	8	0.37	0.00	1.00
9	Alfalfa	USACE	9	0.37	0.00	1.00
10	Alfalfa	USACE	10	0.37	0.00	1.00
11	Alfalfa	USACE	11	0.37	0.00	1.00
12	Alfalfa	USACE	12	0.37	0.00	1.00
13	Alfalfa	USACE	13	0.37	0.00	1.00
14	Alfalfa	USACE	14	0.37	0.00	1.00
15	Alfalfa	USACE	15	0.37	0.00	1.00
16	Alfalfa	USACE	16	0.37	0.00	1.00
17	Alfalfa	USACE	17	0.37	0.00	1.00
18	Alfalfa	USACE	18	0.37	0.00	1.00
19	Alfalfa	USACE	19	0.37	0.00	1.00
20	Alfalfa	USACE	20	0.37	0.00	1.00
21	Alfalfa	USACE	21	0.37	0.00	1.00
22	Alfalfa	USACE	22	0.37	0.00	1.00
23	Alfalfa	USACE	23	0.37	0.00	1.00
24	Alfalfa	USACE	24	0.37	0.00	1.00
25	Alfalfa	USACE	25	0.37	0.00	1.00
26	Alfalfa	USACE	26	0.37	0.00	1.00
27	Alfalfa	USACE	27	0.37	0.00	1.00
28	Alfalfa	USACE	28	0.37	0.00	1.00
29	Alfalfa	USACE	29	0.37	0.00	1.00
30	Alfalfa	USACE	30	0.37	0.00	1.00

Figure 10.4 Agricultural Products Damage Functions

10.5 Restoration Time

Modification of restoration time regards loss of function and repair time of facilities. A distinction should be made between loss of function and repair time. In this methodology, loss of function is defined as the time that a facility is not capable of conducting business. This, in general, will be shorter than repair time because businesses will rent alternative space while repairs and construction are being completed. Loss of function (restoration time) is estimated in the methodology only for essential facilities, transportation lifelines and utility lifelines. Default restoration functions are provided with the methodology for essential facilities, transportation lifelines and utility lifelines. An example of a set of restoration functions is found in Figure 10.5. Restoration curves describe the fraction of facilities (or components in the case of lifelines) that are expected to be open or operational as a function of time following the earthquake. For example, looking at the curves shown in Figure 10.5, 10 days after the earthquake, about 20% of the facilities that were in the extensive damage state immediately after the earthquake and about 60% of the facilities that were in the moderate damage state immediately after the earthquake, are expected to be functional. Each curve is based on a Normal distribution with a mean and standard deviation. The parameters of the restoration functions are accessed through the

Analysis|Restoration Function menu and can be viewed and modified in a window such as the one shown in Figure 10.5.



	EssntFltyClass	FltyDescription	MinimumDepth	MaximumDepth	MaxDaysToRestoratic
1	EFHL	Large Hospital (greater th	8	25	
2	EFHL	Large Hospital (greater th	0	4	
3	EFHL	Large Hospital (greater th	-4	0	
4	EFHL	Large Hospital (greater th	4	8	
5	EFHM	Medium Hospital (50 to 1	8	25	
6	EFHM	Medium Hospital (50 to 1	0	4	
7	EFHM	Medium Hospital (50 to 1	4	8	
8	EFHM	Medium Hospital (50 to 1	-4	0	
9	EFHS	Small Hospital (less than	4	8	
10	EFHS	Small Hospital (less than	0	4	
11	EFHS	Small Hospital (less than	8	25	
12	EFHS	Small Hospital (less than	-4	0	
13	EFMC	Medical Clinics and Labs	4	8	
14	EFMC	Medical Clinics and Labs	0	4	
15	EFMC	Medical Clinics and Labs	-4	0	
16	EFMC	Medical Clinics and Labs	8	12	
17	EFMC	Medical Clinics and Labs	12	25	
18	MDFLT	Default for Medical	-4	0	
19	MDFLT	Default for Medical	0	4	
20	MDFLT	Default for Medical	4	8	
21	MDFLT	Default for Medical	8	25	

Figure 10.5 Restoration Functions for Essential Facilities

Typing in a new value and then clicking on the **Close** button will modify parameters for restoration curves. You will be asked to confirm that you want to save your changes. It is strongly recommended that you use the default parameters unless you have expertise in the development of restoration functions.

10.6 Analysis Parameters

The Analysis Parameters are factors or variables within the analysis that users can modify. The six factors that are available for modification are Debris, Casualties, Shelter, Agricultural, Direct Economic Loss, and Indirect Economic Loss. They are each detailed in the following pages.

10.6.1 Debris Parameters

The Debris Parameters are based on the depth of the flood within a structure by ranges. It shows the expected debris to be produced; the debris from a structure and footing or slab is only produced when the structure is demolished. This is based on dry wall and other components that are replaced in manageable units instead of the area of actual damage. Users can modify as desired. The weights are in tons per thousand square feet of the structure. Figure 10.6 is an example of the Debris Parameters window.

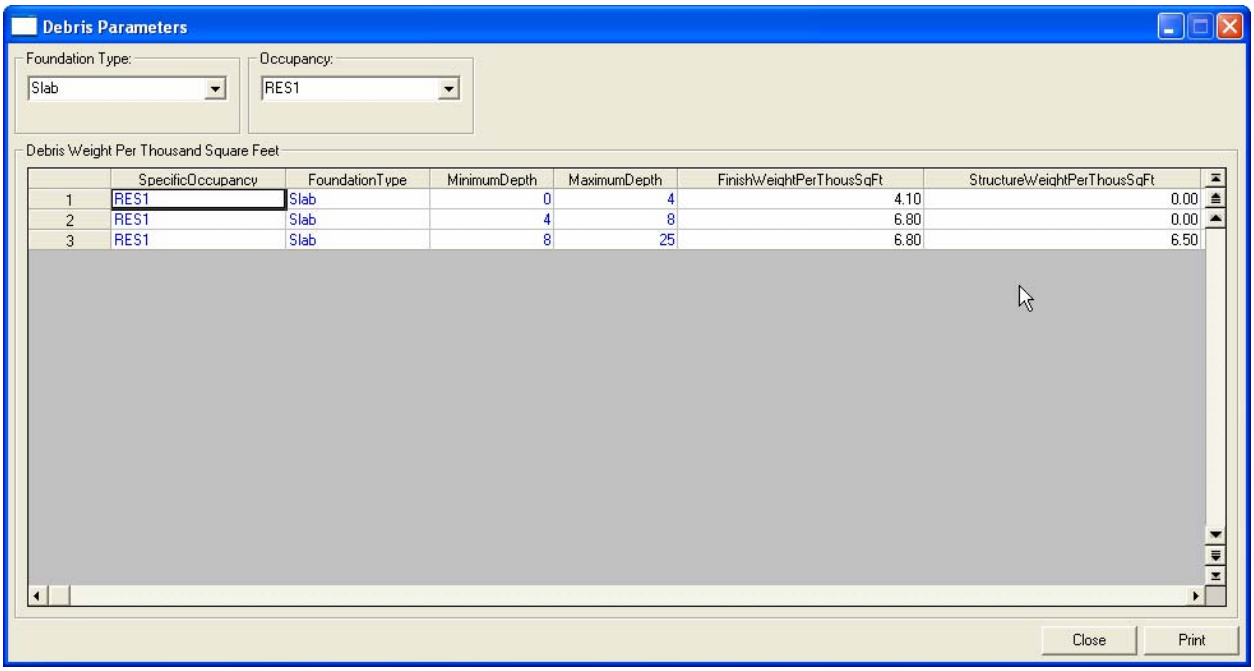


Figure 10.6 Debris Parameters

10.6.2 Casualties Parameters

Unfortunately, the Flood Model does not have Casualties Parameters. When a user selects the Casualties Parameters while in the Flood Model, the word document that opens can be seen in Figure 10.7.

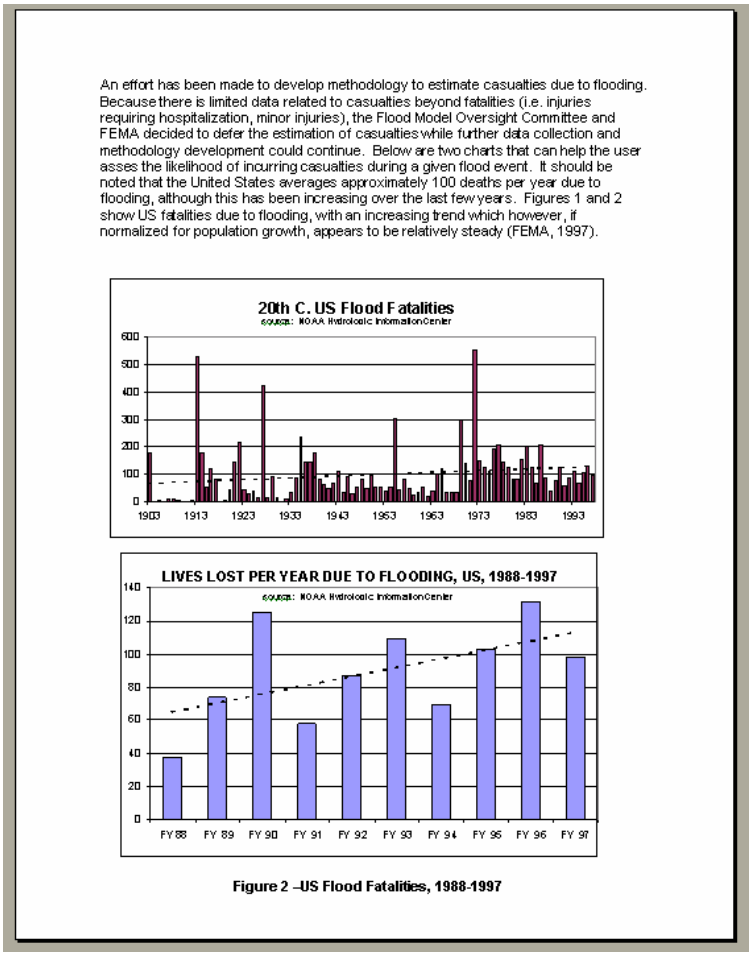

An effort has been made to develop methodology to estimate casualties due to flooding. Because there is limited data related to casualties beyond fatalities (i.e. injuries requiring hospitalization, minor injuries), the Flood Model Oversight Committee and FEMA decided to defer the estimation of casualties while further data collection and methodology development could continue. Below are two charts that can help the user asses the likelihood of incurring casualties during a given flood event. It should be noted that the United States averages approximately 100 deaths per year due to flooding, although this has been increasing over the last few years. Figures 1 and 2 show US fatalities due to flooding, with an increasing trend which however, if normalized for population growth, appears to be relatively steady (FEMA, 1997).
20th C. US Flood Fatalities
source: NOAA Hydrologic Information Center
600
500
400
300
200
100
0
1903
1913
1923
1933
1943
1953
1963
1973
1983
1993
LIVES LOST PER YEAR DUE TO FLOODING, US, 1988-1997
source: NOAA Hydrologic Information Center
140
120
100
80
60
40
20
0
FY 88
FY 89
FY 90
FY 91
FY 92
FY 93
FY 94
FY 95
FY 96
FY 97
Figure 2 –US Flood Fatalities, 1988-1997

Figure 10.7 Casualties Parameters

10.6.3 Shelter Parameters

Shelter Parameters depend on four factors: Evacuation, Utility Factors, Weighting Factors, and Modification Factors. Under the *Evacuation* tab, users are allowed to choose the depth at which ingress/egress is restricted (depth at which flood waters are considered dangerous to drive or walk through). It also allows the user to set the evacuation buffer that surrounds the flooded area for public safety. The *Utility Factors* accounts for the duration or lack of access caused by the utility factors. The *Weighting Factors* are based on income and age. These factors establish the assumed percentage of the population that will seek shelter based on their income and age. The *Modification Factors* adjust the population that will seek public shelter based on the range of

their income and age. It allows the user to modify the range or income or age. Figure 10.8 shows the Shelter Parameters window.

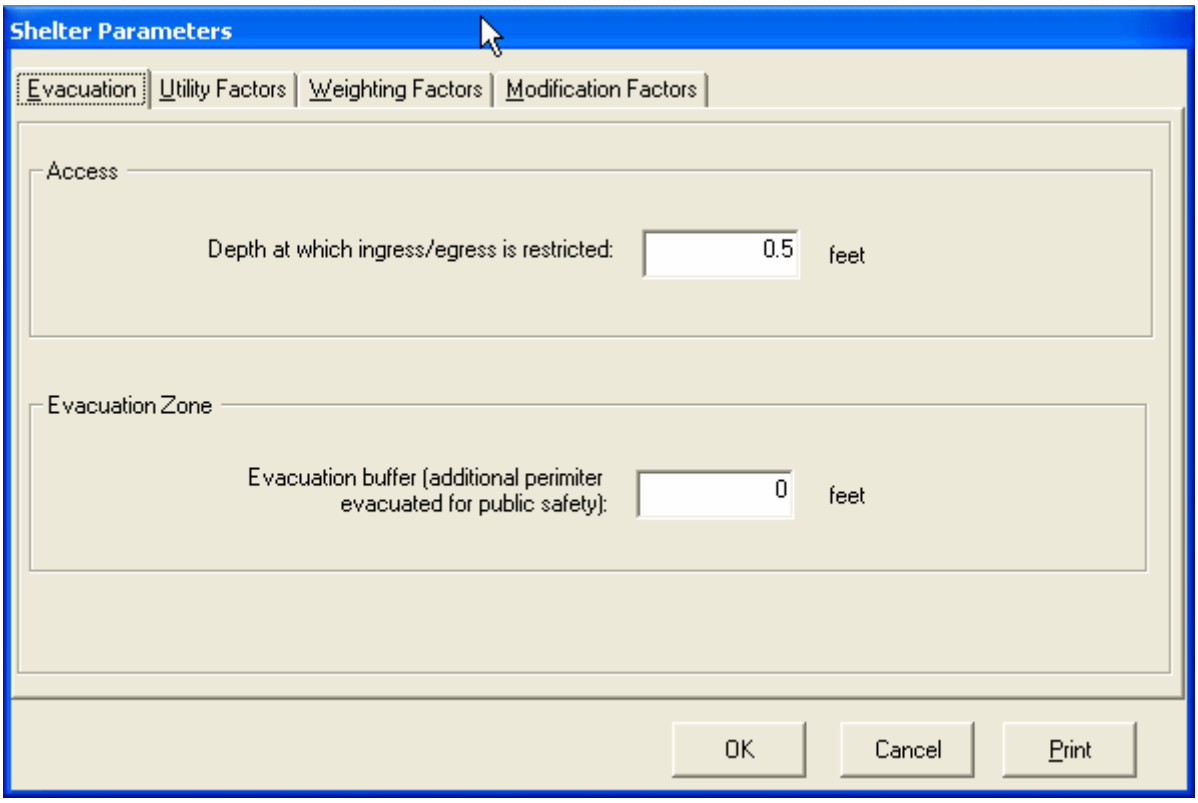


Figure 10.8 Shelter Parameters

10.6.4 Agricultural Parameters

The Agricultural Parameters asks the user to supply the day and month of the flood event. **HAZUS** will then adjust the date to the Julian calendar, which is based on the growing season.

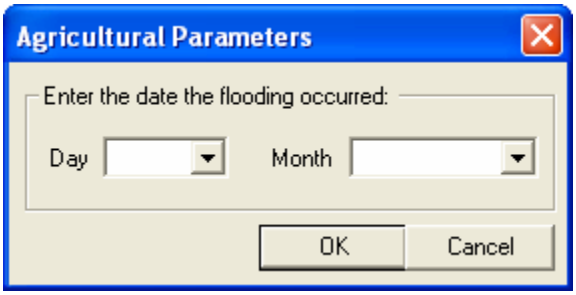


Figure 10.9 Agricultural Parameters

10.6.5 Direct Economic Loss Parameters

The Direct Economic Loss Parameters are based on three factors: Business Inventory, Restoration Time, and Income Loss Data. The *Business Inventory* tab can be viewed as the Annual Gross Sales in dollars per square foot or as the percentage of Gross Annual Sales for each specific occupancy. *Restoration Time* is the anticipated time for repair and restoration before the population can move back in. The *Income Loss Data* includes the relocation expenses and loss of income. An example of the Direct Economic Loss Parameters window can be seen in Figure 10.10.

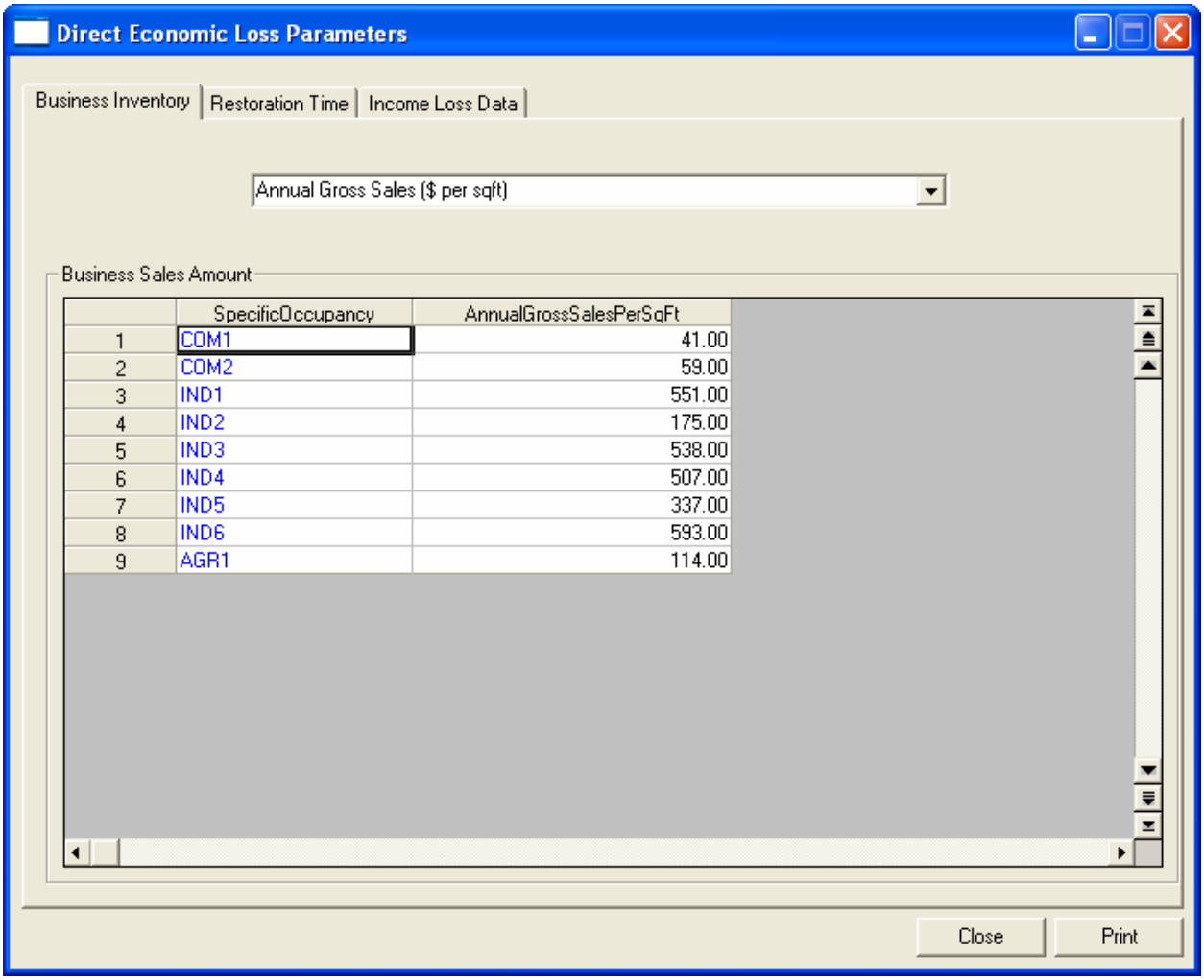


Figure 10.10 Direct Economic Loss Parameters

10.6.6 Indirect Economic Loss Module with a Synthetic Economy

Estimates of indirect losses can be calculated using a very simplified model of the regional economy. **HAZUS** contains twelve built-in "synthetic" economies. These "synthetic economies" are based on aggregating characteristics from a number of regional economies around the country and creating three typical economy types:

- Primarily manufacturing
- Primarily service with manufacturing as the secondary sector
- Primarily service with trade as the secondary sector

Each economy is broken into four size classifications:

- Super (greater than 2 million in employment)
- Large (greater than 0.6 million but less than 2 million in employment)
- Mid Range (greater than 30,000 but less than 0.6 million in employment)
- Low (less than 30,000 in employment)

The indirect economic impact module selects the most appropriate synthetic economy to use for the study region based on user inputs describing the size of the economy (number of employees) and the type of economy. In order to run the module using a synthetic economy, you must identify the type and size of economy using the window shown in Figure 10.11. To access the screen, select the **Indirect economic** option in the **Analysis|Parameters** menu.

The default type of economy is "primarily manufacturing." You should overwrite this if "service/manufacturing" or "service/trade" is a more accurate characterization of your region. The economy type can be determined by evaluating the percent of regional employment in each of the major industries. For further guidance, consult the *Technical Manual*.

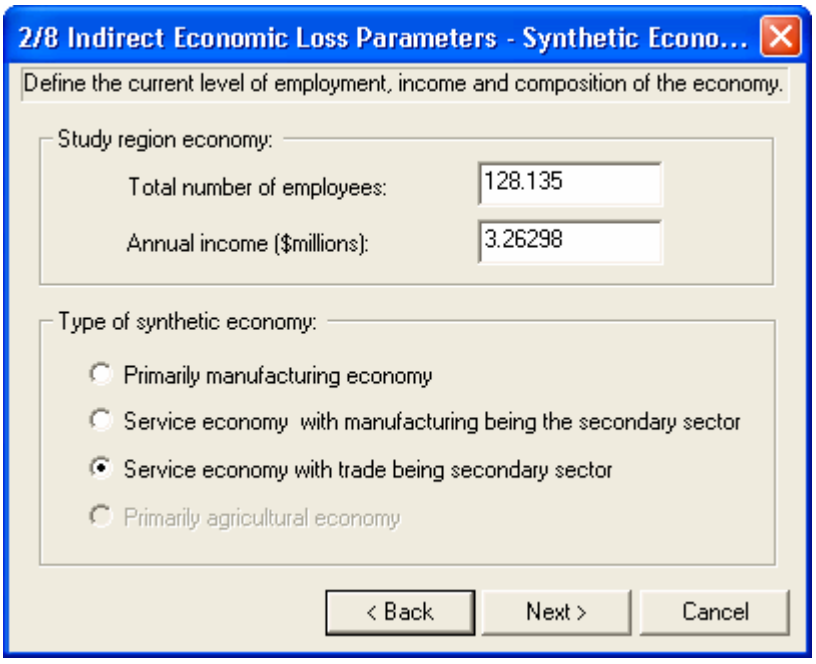

2/8 Indirect Economic Loss Parameters - Synthetic Econo...
Define the current level of employment, income and composition of the economy.
Study region economy:
Total number of employees:
128.135
Annual income ($millions):
3.26298
Type of synthetic economy:
Primarily manufacturing economy
Service economy with manufacturing being the secondary sector
Service economy with trade being secondary sector
Primarily agricultural economy
< Back
Next >
Cancel

Figure 10.11 Setting Parameters for Synthetic Economy

HAZUS provides a default employment figure based on the counties in the study region. The source of this default data is the Bureau of Economic Analysis. You should review this number against available local information and overwrite it if appropriate. Employment should be measured by place of *work* rather than by place of *residence*. This distinction is especially significant when there is substantial commuting across the region's borders. In addition to employment, the default figure provided for regional income should be reviewed and overwritten if appropriate. After you have defined the synthetic economy and clicked on the **<Next>** button in Figure 10.11 the window in Figure 10.12 will appear. Figures 10.13 through 10.15 allow you to modify economic factors that relate to the general capacity and the economy's ability to restore itself following the earthquake. Default values for all of the factors are provided for use in analysis. However, you should still review at the least the following factors and replace the default values as appropriate:

- Unemployment rate
- Level of outside aid and/or insurance
- Interest rate on loans

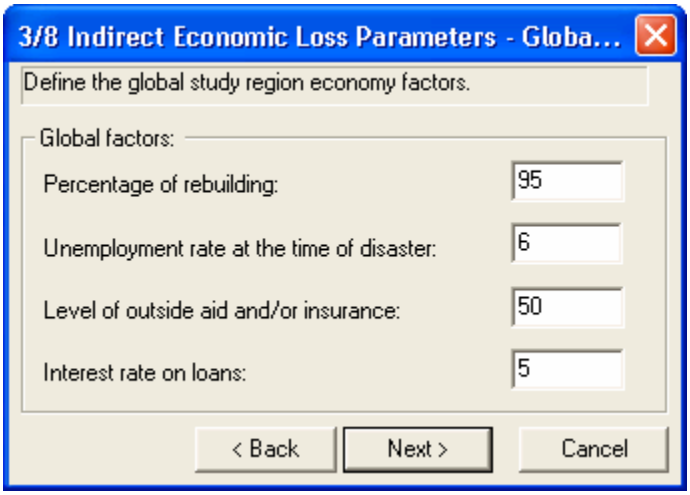


Figure 10.12 Setting the Indirect Economic Factors

Default values are provided for four global factors as shown in Figure 10.12. The **Percentage of rebuilding** is used by the module to estimate the size of the reconstruction stimulus to the economy. The **Unemployment rate at the time of the disaster** serves as an indicator of excess capacity or slack in the economy; the indirect losses are generally higher when the economy has low unemployment because there is less unused capacity that can help make up for capacity lost due to earthquake damage. The **Level of outside aid and/or insurance** is a major determinant of the long-term income effects of the disaster since the amount of reconstruction funded by borrowing within the region will in the long term cause indebtedness. The **Interest rate on loans** also affects the amount of indebtedness arising from reconstruction financing.

Again, these should be reviewed and modified where appropriate. In some cases you may wish to run several analyses using different values, such as **Level of outside aid and/or insurance**, to investigate the effect of this parameter on indirect economic impacts. When you have finished with the **Factors** tab, click on the **Restoration & Rebuilding** tab to view the screen in Figure 10.13.

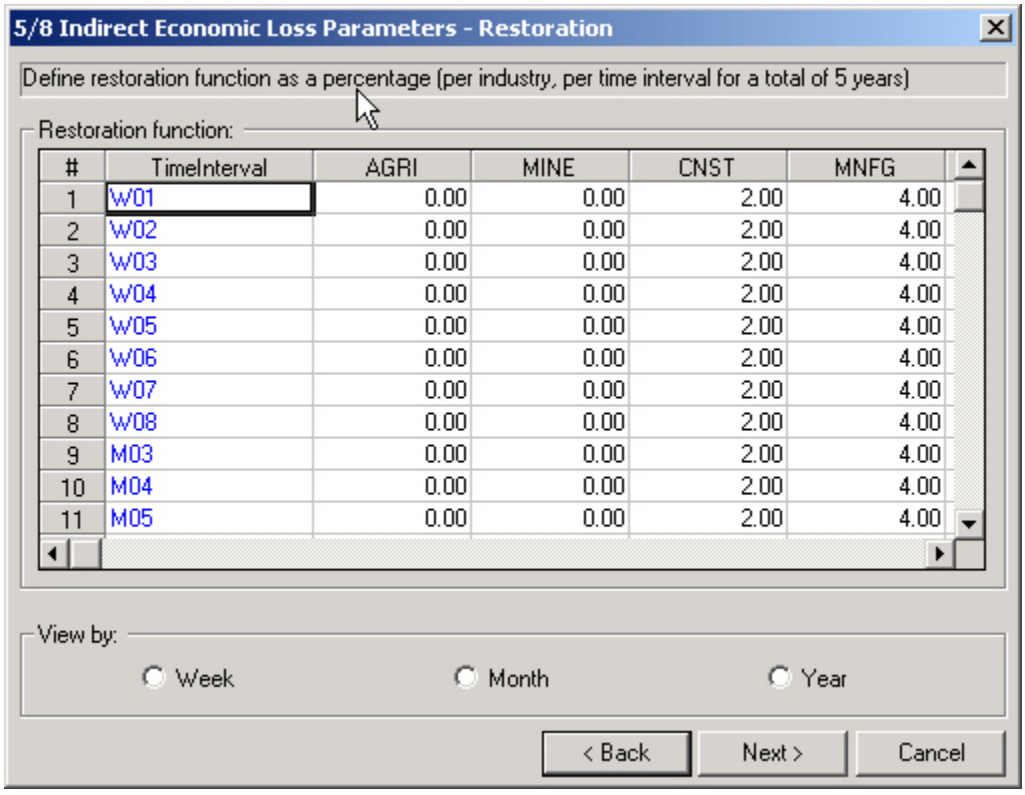

5/8 Indirect Economic Loss Parameters - Restoration
Define restoration function as a percentage (per industry, per time interval for a total of 5 years)
Restoration function:
TimeInterval AGRI MINE CNST MNFG
1 W01 0.00 0.00 2.00 4.00
2 W02 0.00 0.00 2.00 4.00
3 W03 0.00 0.00 2.00 4.00
4 W04 0.00 0.00 2.00 4.00
5 W05 0.00 0.00 2.00 4.00
6 W06 0.00 0.00 2.00 4.00
7 W07 0.00 0.00 2.00 4.00
8 W08 0.00 0.00 2.00 4.00
9 M03 0.00 0.00 2.00 4.00
10 M04 0.00 0.00 2.00 4.00
11 M05 0.00 0.00 2.00 4.00
View by:
Week
Month
Year
< Back
Next >
Cancel

Figure 10.13 Setting the Indirect Economic Restoration and Rebuilding Factors

The dialog shows default values for industry restoration functions for each of the first 5 years. Units are in percentage points of industry *loss* of function or production capacity in each year. Default values may be overwritten for consistency with results related to physical damage (See section 16.5.2.2 in the *Earthquake Technical Manual*). The rebuilding factors as shown in Figure 10.14 has default values for "% of Total Rebuilding Expenditures" in each of the first 5 years for buildings and lifelines, respectively. In general, most of the rebuilding is expected to occur in the first 1-2 years after the disaster. Lifeline reconstruction expenditures are expected to be made proportionately earlier than buildings reconstruction. Default values can be overwritten for consistency with results on physical damage (See the *Technical Manual* for more information).

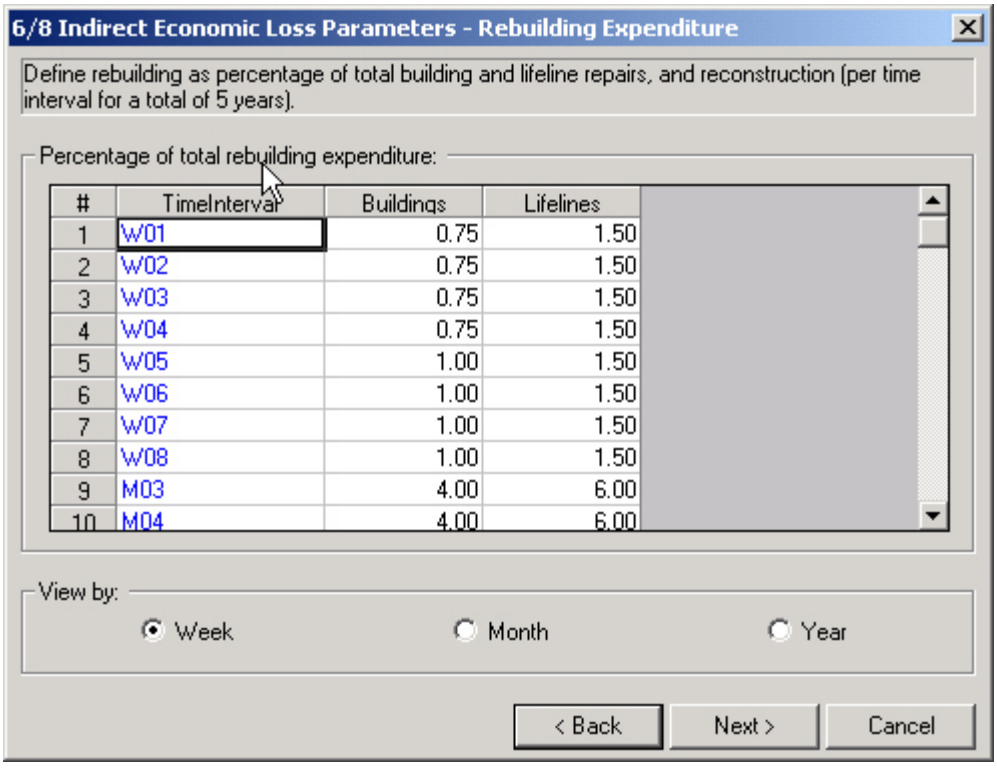

6/8 Indirect Economic Loss Parameters - Rebuilding Expenditure
Define rebuilding as percentage of total building and lifeline repairs, and reconstruction (per time interval for a total of 5 years).
Percentage of total rebuilding expenditure:
TimeInterval Buildings Lifelines
1 W01 0.75 1.50
2 W02 0.75 1.50
3 W03 0.75 1.50
4 W04 0.75 1.50
5 W05 1.00 1.50
6 W06 1.00 1.50
7 W07 1.00 1.50
8 W08 1.00 1.50
9 M03 4.00 6.00
10 M04 4.00 6.00
View by:
Week
Month
Year
< Back
Next >
Cancel

Figure 10.14 Setting the Indirect Economic Rebuilding Factors

The last factors that can be altered are the Stimulus Values. By clicking on the Stimulus Values tab, you can access the screen shown in Figure 10.15.

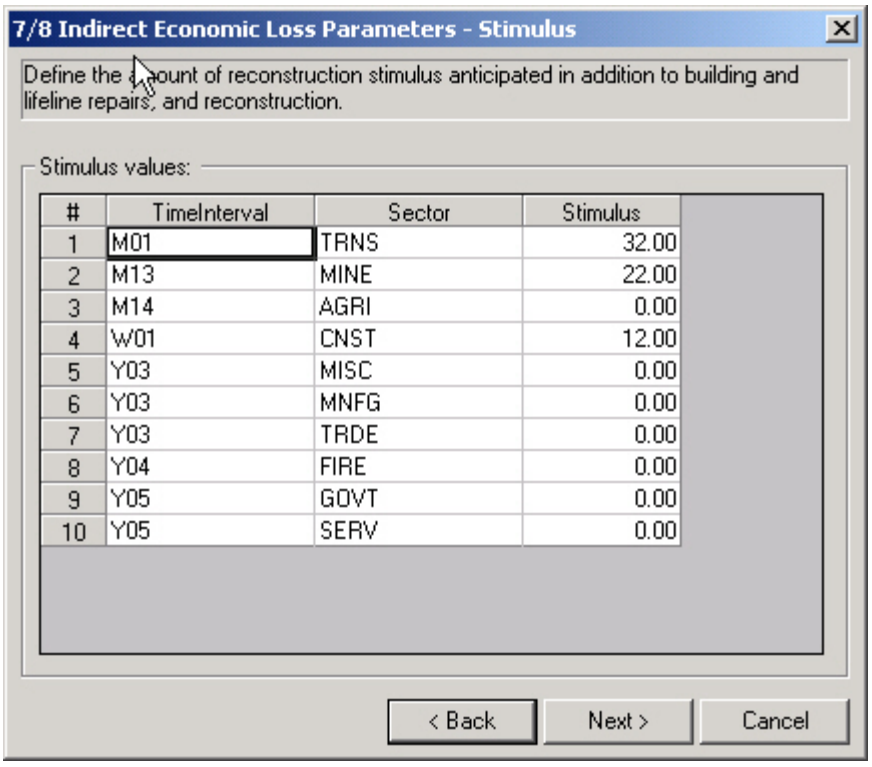

7/8 Indirect Economic Loss Parameters - Stimulus
Define the amount of reconstruction stimulus anticipated in addition to building and lifeline repairs, and reconstruction.
Stimulus values:
TimeInterval Sector Stimulus
1 M01 TRNS 32.00
2 M13 MINE 22.00
3 M14 AGRI 0.00
4 W01 CNST 12.00
5 Y03 MISC 0.00
6 Y03 MNFG 0.00
7 Y03 TRDE 0.00
8 Y04 FIRE 0.00
9 Y05 GOVT 0.00
10 Y05 SERV 0.00
< Back
Next >
Cancel

Figure 10.15 Setting the Stimulus Values

The parameters in Figure 10.15 represent an anticipated stimulus to the economy in addition to repair and reconstruction of buildings and lifelines. The defaults are all zero. **HAZUS** includes the capability of inputting a higher resolution timeframe for the restorations factors, the rebuilding factors and the stimulus values. In **HAZUS** the factors can be specified on a weekly basis for the first 2 months (8 weeks), on a monthly basis for the first 2 years (month 3 through 24), and yearly thereafter (year 3 through 5.) Click **OK** after completing selections on this screen. This completes the user input requirements. The module can be run by clicking on the **Indirect economic loss** option in the **Analysis|Run...** menu.

10.6.7 Running the Indirect Economic Loss Module with IMPLAN Data

For a more realistic analysis the indirect economic module can use IMPLAN data for modeling the economy. Select **Use IMPLAN data files** from the **Indirect Economic Analysis Type** screen. The default employment and income figures on the screen will not be used. Instead, the module will automatically pick off more accurate data from the IMPLAN data files you provide (see the *Technical Manual*). You do not have to make a selection under **Type of Synthetic**

Economy. Click **OK** after completing selections on this screen and the **IMPLAN** Files screen shown in Figure 10.16 will appear.

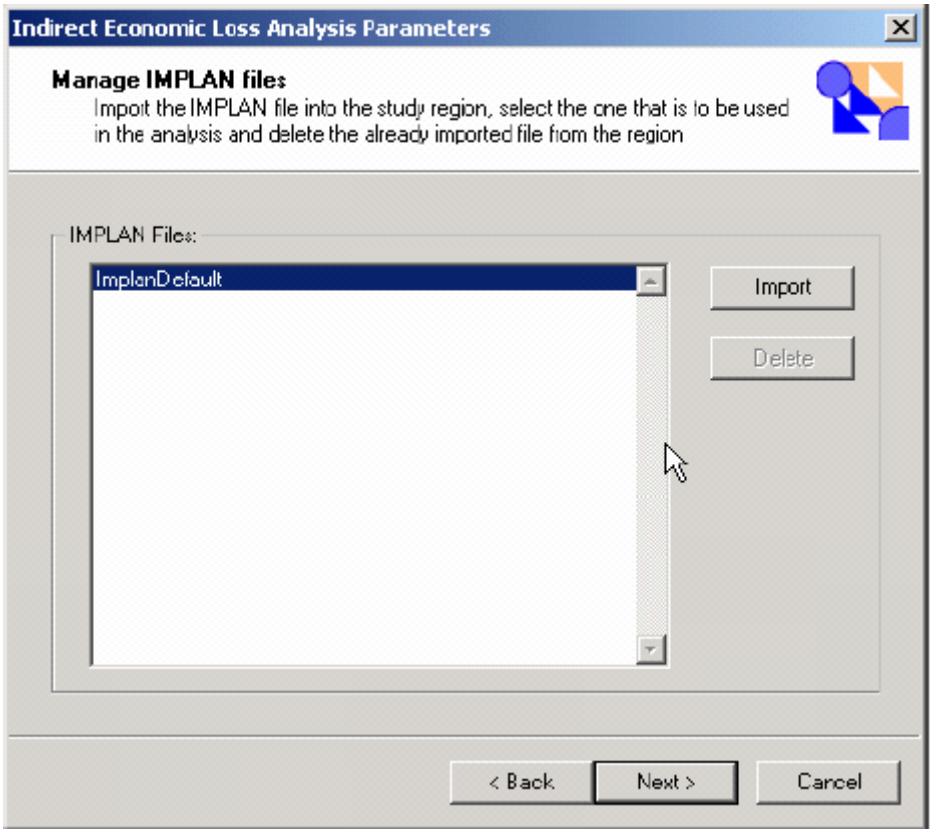

Indirect Economic Loss Analysis Parameters
Manage IMPLAN files
Import the IMPLAN file into the study region, select the one that is to be used in the analysis and delete the already imported file from the region
IMPLAN Files:
ImplanDefault
Import
Delete
< Back
Next >
Cancel

Figure 10.16 Screen for Importing IMPLAN Files

The screen contains a box listing available **IMPLAN** files. If the user has not imported any files, only one file labeled **IMPLANDF** (for IMPLAN default) is listed. This indicates the default synthetic economy.

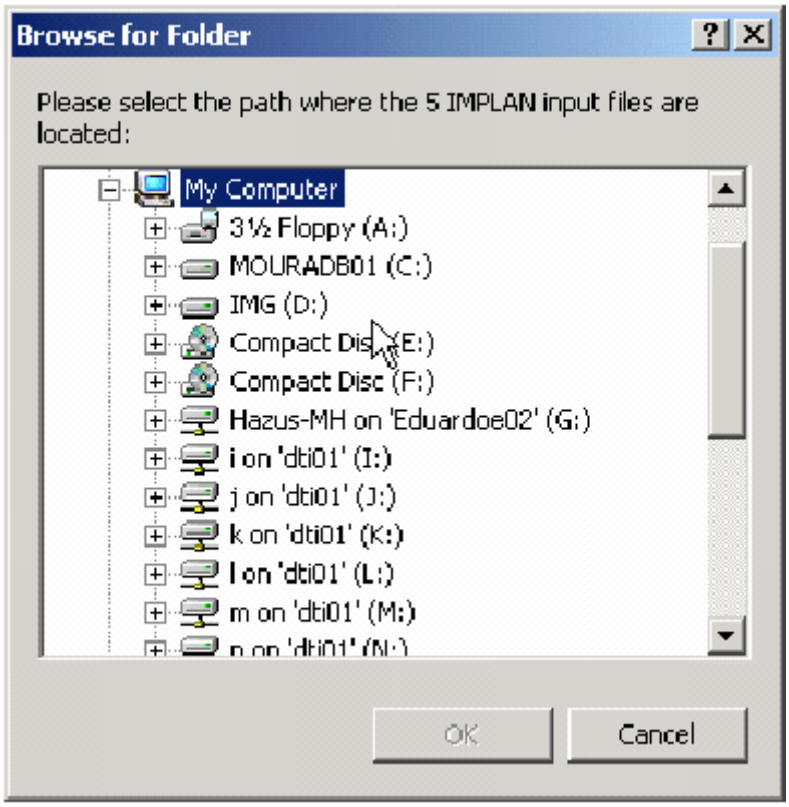


Figure 10.17 Locating IMPLAN Files

Use the **Import** button to import **IMPLAN** files into **HAZUS**. Note that **HAZUS** only prompts you for the directory that contains the required files. All five files should be located in the same directory. Chapter 16 of the **HAZUS** Earthquake Technical Manual provides the information of the files required by the module. The newly imported **IMPLAN** file name now appears underneath **IMPLANDF**. Use the mouse to highlight the new **IMPLAN** file, thus selecting it for use in the analysis. Click **OK** and the Indirect Economic Analysis Factors screen will appear.

If you have previously imported an **IMPLAN** data file(s), its name(s) will appear on the list. Remember to highlight the correct file each time before clicking **OK** to ensure that **HAZUS** does not return to using the default **IMPLANDF** file. Follow the steps outlined in Section 10.6.6 for specifying indirect economic analysis factors. Run the **Analysis|Run...** menu.

Chapter 11 Viewing and Reporting the Results

This chapter describes the results tables, maps, and reports produced by the Flood Model. The items discussed are accessed via the **Results** menu after performing an analysis.

11.1 Guidance for Reporting Loss Results

There is no single format that is appropriate for presentation of loss study results. The format will depend on the use of the results and the intended audience. The audience can vary from the general public to technical experts. Decision makers such as city council members and other government officials may require only summaries of losses for a region. Emergency response planners may want to see the geographical distribution of all losses and damage for several different flood scenarios. **HAZUS** provides a great deal of flexibility in presenting results. Results can be presented in a tabular or map form. The users of the results should be involved from the beginning in determining the types and formats of the results that best suit their needs.

In previous loss studies, authors of reports have had the difficult task of trying to combine the study results with the theory of how they were calculated. Consequently, reports often seemed overly technical, reducing their readability and usefulness for many audiences. **HAZUS** users can refer to the *Technical Manual*, which describes all of the theories and equations that provide the basis of any loss estimate. Thus, reports do not need to, and probably should not include technical discussions of theory. Instead, reports should focus on describing results in non-technical language that is easily understood by the intended audience.

While no particular format for presenting results can be recommended, several general statements about reporting of results can be made. Reports should serve to clarify the meaning of the loss estimates. For example, the report should indicate whether losses are due only to building and contents damage or if they also include monetary losses resulting from loss of function. It should be clarified that losses are not calculated for individual buildings, but instead are based on the performances of entire classes of buildings. These are just a few examples of the types of clarifications that should appear in reports.

Reports should also clarify for the reader what assumptions were made in developing the scenario and inventory and in calculating losses. For example, were losses based on default inventories or were default inventories augmented? Were default analysis parameters used? If not, what values were used? What assumptions were made in selecting the scenario flood? Is it based on an historical event? Is it based on an expected probability of occurrence (e.g., a 100-year return period event)? What types of assumptions were made about the building stock?

A criticism of past studies is that there has been little qualitative or quantitative treatment of uncertainty. Discussions with users of previous studies have indicated that users need information about where errors in prediction are most likely to occur. While this methodology does not explicitly include a technique for carrying the uncertainty of each variable through the entire set of calculations, sensitivity analyses are useful for providing bounds on loss estimates. At a minimum, reports should make some statement about the uncertainty of the input values.

11.2 Hazard Results

The **Results | Flood Hazard Maps | Thematic Map of Depth** command allows you to map the flood depth grid and floodplain boundary for the current scenario and return period/discharge(s). The flood depth grid has vertical units of feet and is displayed in blue. The floodplain boundary is displayed in orange.

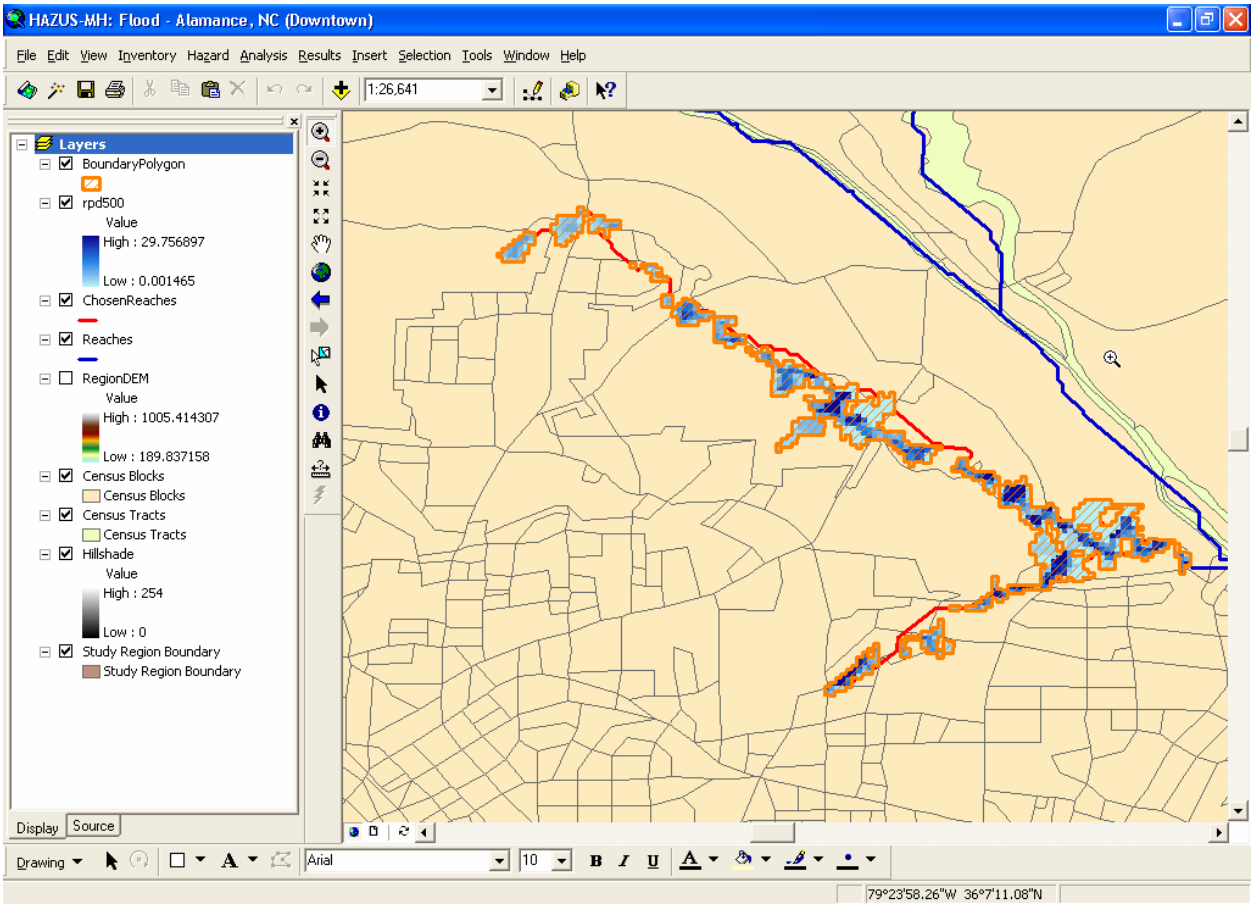


Figure 11.1 Flood Depth Grid and Floodplain Boundary

HAZUS automatically maps the flood depth grid and floodplain boundary when the hazard is computed, but it is still available for other flood depth grids that may have been computed.

11.3 General Building Stock

The **Results | General Building Stock Damage** command allows you to view and map the general inventory damage results by occupancy, building type, and building count. The values in the table represent the expected fraction of building square footage in each damage state. The drop-down boxes allow you to select the occupancy type and pre/post FIRM status.

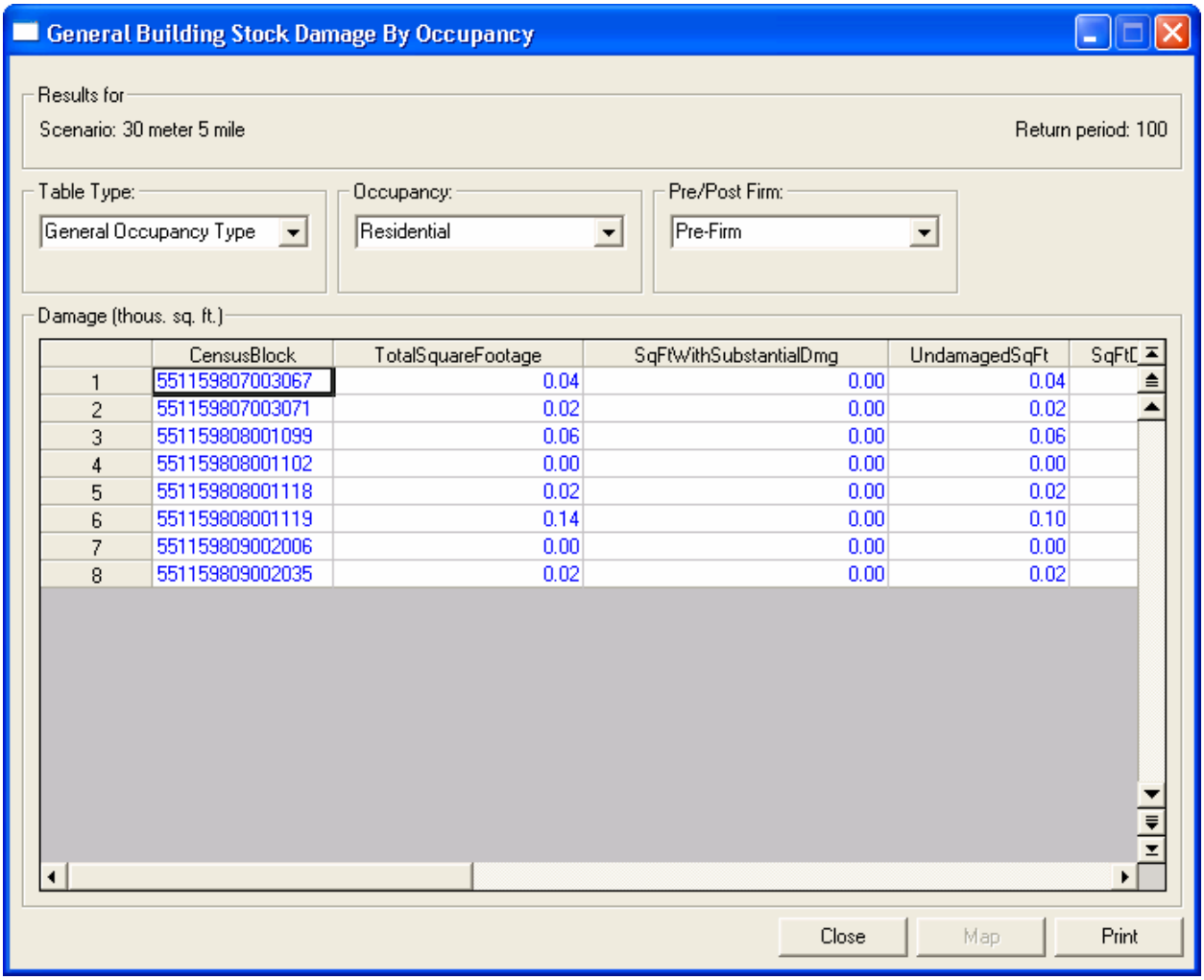


Figure 11.2 General Building Stock Damage Results

11.4 Essential Facilities

The **Results | Essential Facilities** command allows you to view and map the damage and loss of use results for hospitals, police stations, fire stations, emergency operations centers, and schools.

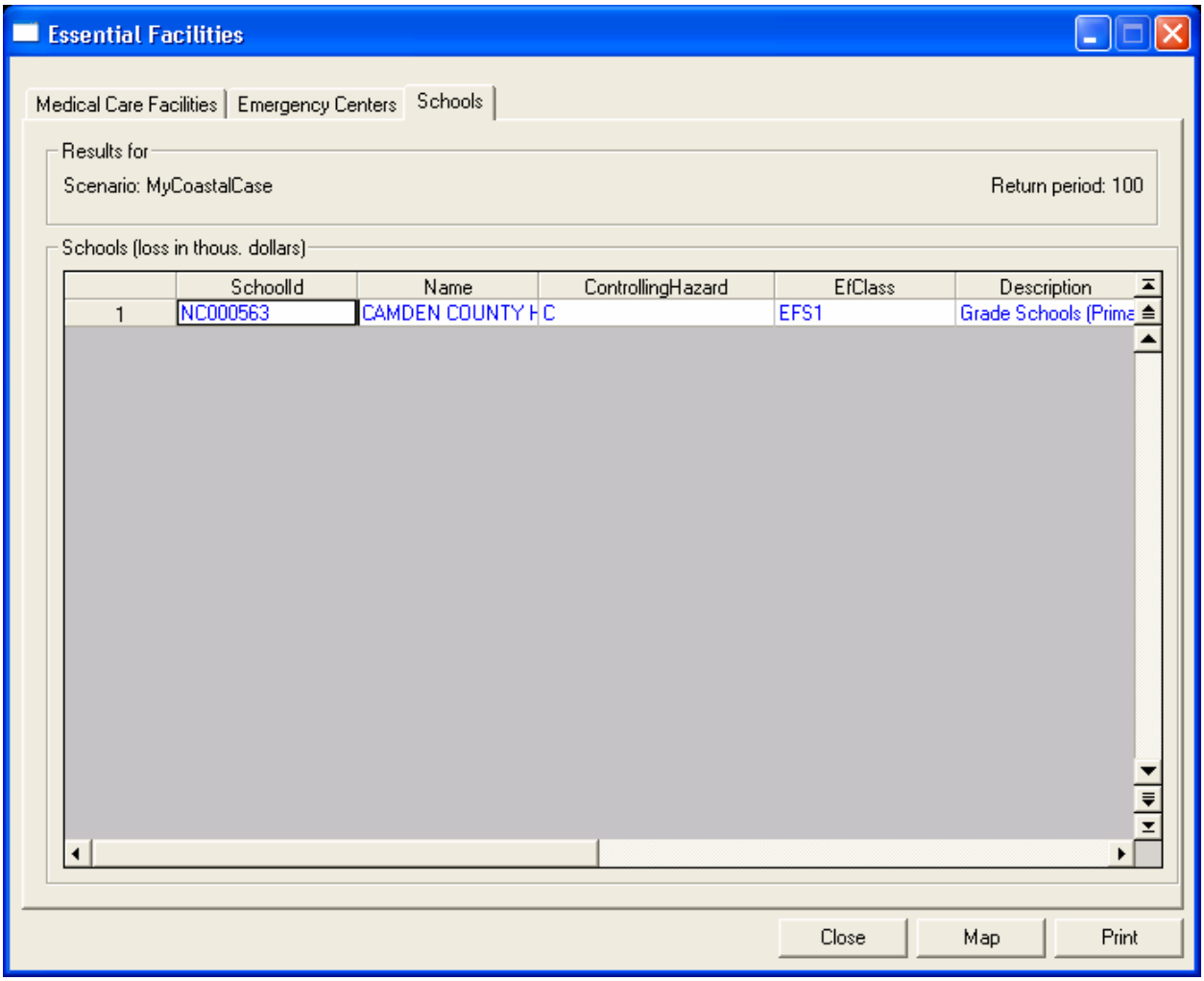


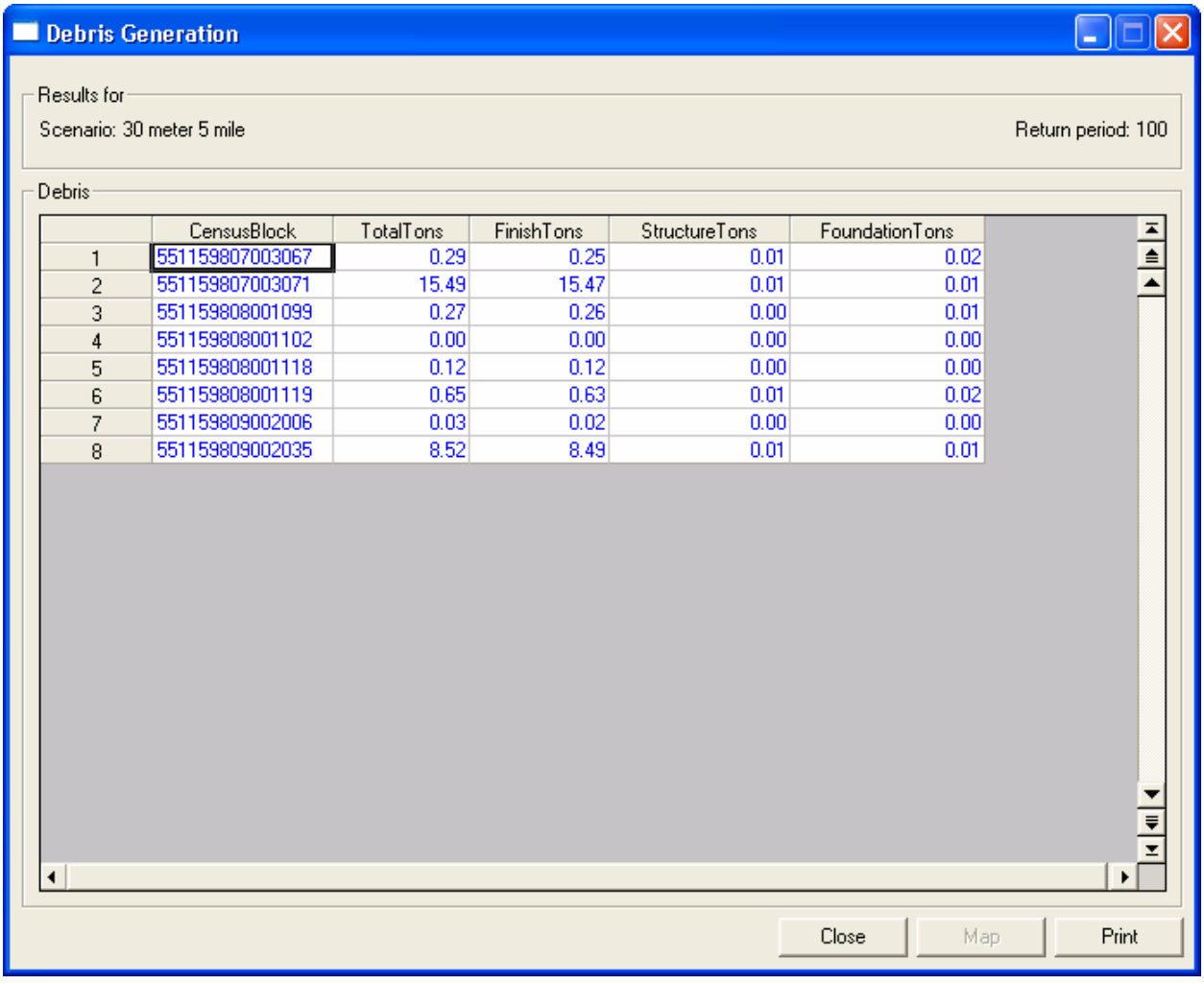
Figure 11.3 Essential Facilities Damage Results

11.5 User-Defined Facilities

The **Results | User-Defined Facilities** command allows you to view the damage results for individual, user-specified facilities. Damage probabilities are provided for overall building damage.

11.6 Debris

The **Results | Debris Generation** command allows you to view and map building and tree debris results by census block.

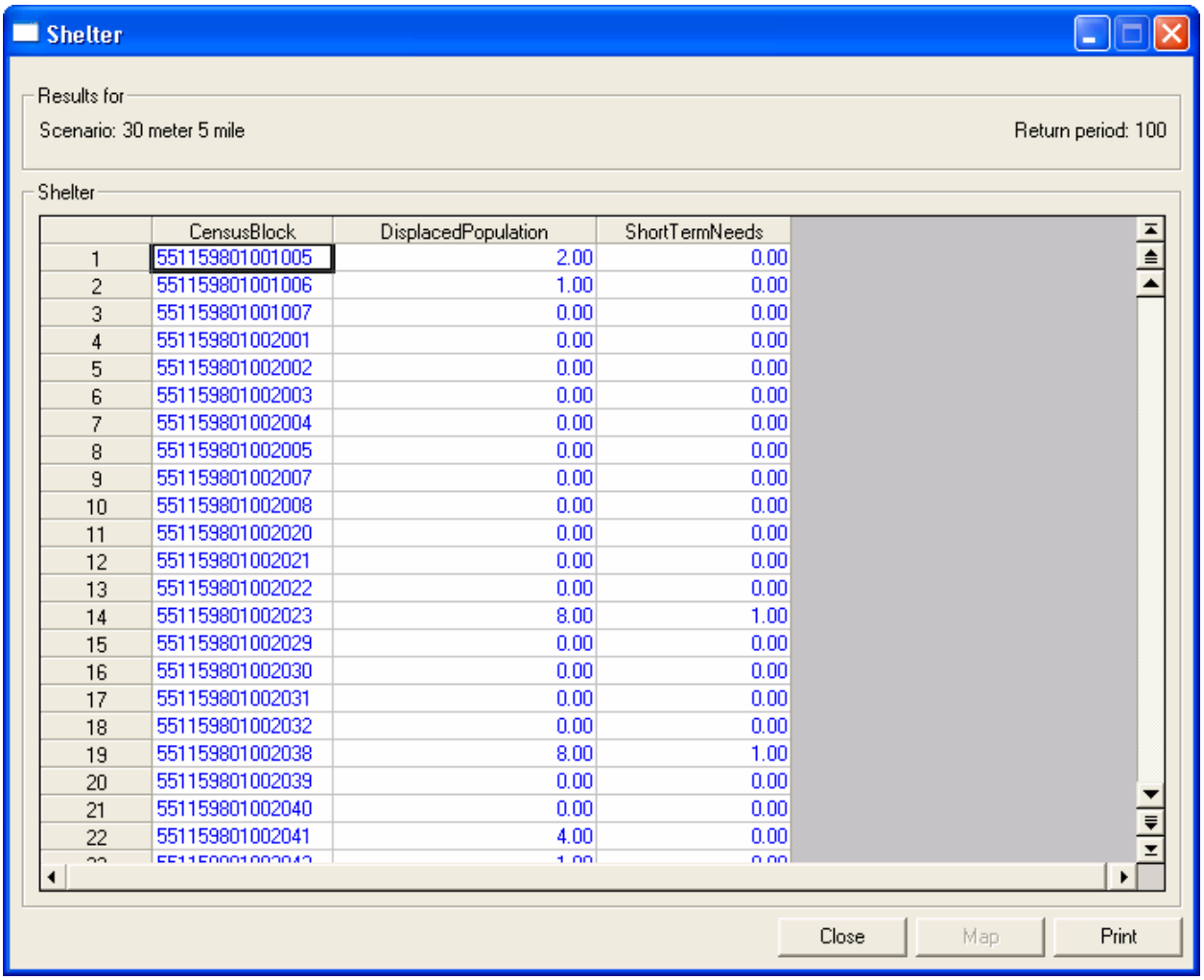


	CensusBlock	TotalTons	FinishTons	StructureTons	FoundationTons
1	551159807003067	0.29	0.25	0.01	0.02
2	551159807003071	15.49	15.47	0.01	0.01
3	551159808001099	0.27	0.26	0.00	0.01
4	551159808001102	0.00	0.00	0.00	0.00
5	551159808001118	0.12	0.12	0.00	0.00
6	551159808001119	0.65	0.63	0.01	0.02
7	551159809002006	0.03	0.02	0.00	0.00
8	551159809002035	8.52	8.49	0.01	0.01

Figure 11.4 Debris Results

11.7 Shelter

The **Results | Shelter** command allows you to view and map the estimated number of displaced households and the estimated short-term shelter needs by census block.

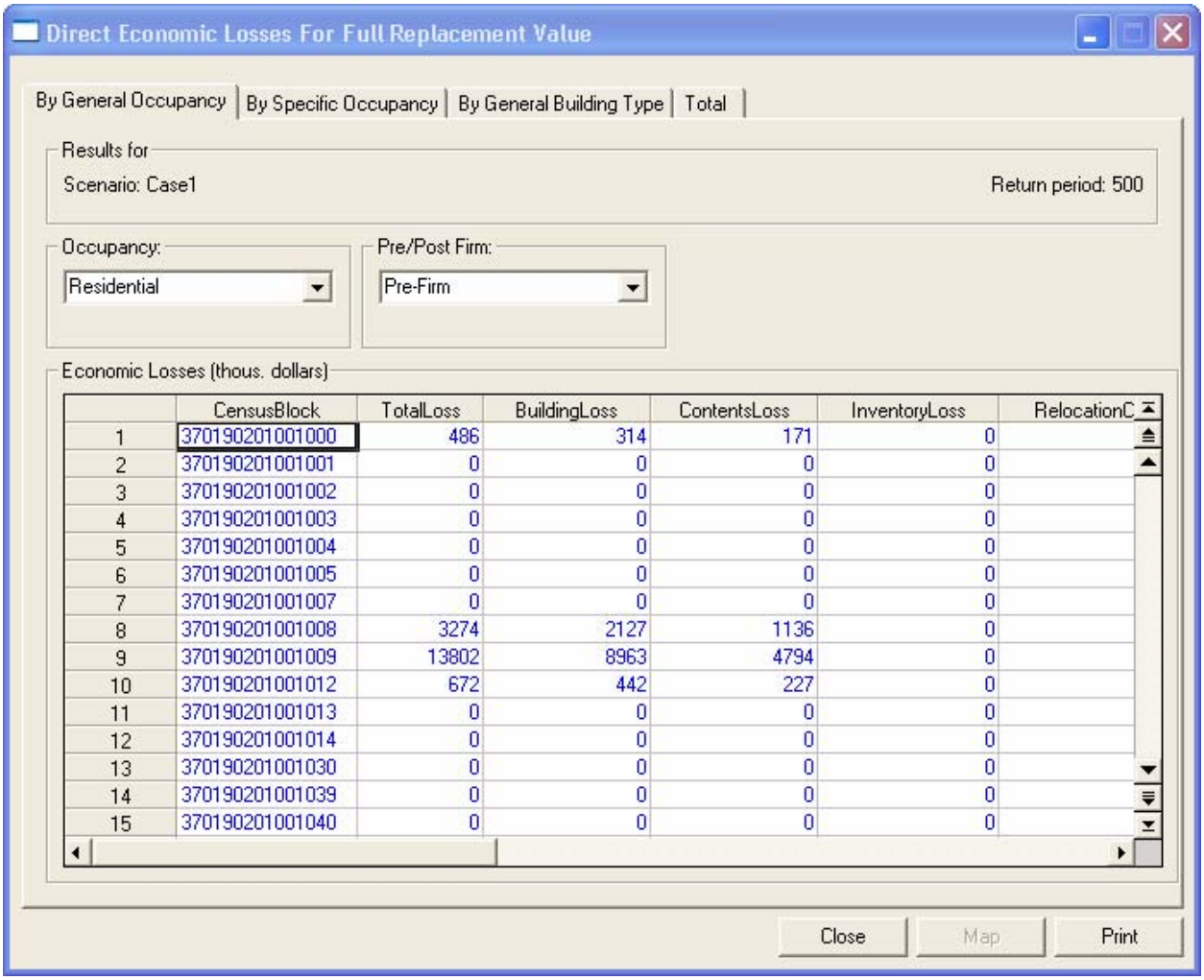


	CensusBlock	DisplacedPopulation	ShortTermNeeds
1	551159801001005	2.00	0.00
2	551159801001006	1.00	0.00
3	551159801001007	0.00	0.00
4	551159801002001	0.00	0.00
5	551159801002002	0.00	0.00
6	551159801002003	0.00	0.00
7	551159801002004	0.00	0.00
8	551159801002005	0.00	0.00
9	551159801002007	0.00	0.00
10	551159801002008	0.00	0.00
11	551159801002020	0.00	0.00
12	551159801002021	0.00	0.00
13	551159801002022	0.00	0.00
14	551159801002023	8.00	1.00
15	551159801002029	0.00	0.00
16	551159801002030	0.00	0.00
17	551159801002031	0.00	0.00
18	551159801002032	0.00	0.00
19	551159801002038	8.00	1.00
20	551159801002039	0.00	0.00
21	551159801002040	0.00	0.00
22	551159801002041	4.00	0.00

Figure 11.5 Shelter Results

11.8 Buildings Economic Loss

The **Results | General Building Stock Economic Loss** command allows you to view and map economic losses for the general building stock by census block by full replacement value and depreciated replacement value.



	CensusBlock	TotalLoss	BuildingLoss	ContentsLoss	InventoryLoss	RelocationC
1	370190201001000	486	314	171	0	
2	370190201001001	0	0	0	0	
3	370190201001002	0	0	0	0	
4	370190201001003	0	0	0	0	
5	370190201001004	0	0	0	0	
6	370190201001005	0	0	0	0	
7	370190201001007	0	0	0	0	
8	370190201001008	3274	2127	1136	0	
9	370190201001009	13802	8963	4794	0	
10	370190201001012	672	442	227	0	
11	370190201001013	0	0	0	0	
12	370190201001014	0	0	0	0	
13	370190201001030	0	0	0	0	
14	370190201001039	0	0	0	0	
15	370190201001040	0	0	0	0	

Figure 11.6 Buildings Economic Loss Results – Full Replacement Value

11.9 Summary Reports

The **Results | Summary Reports** command allows you to select one of several summary reports for viewing and printing. The reports will be generated using the Crystal Reports report engine.

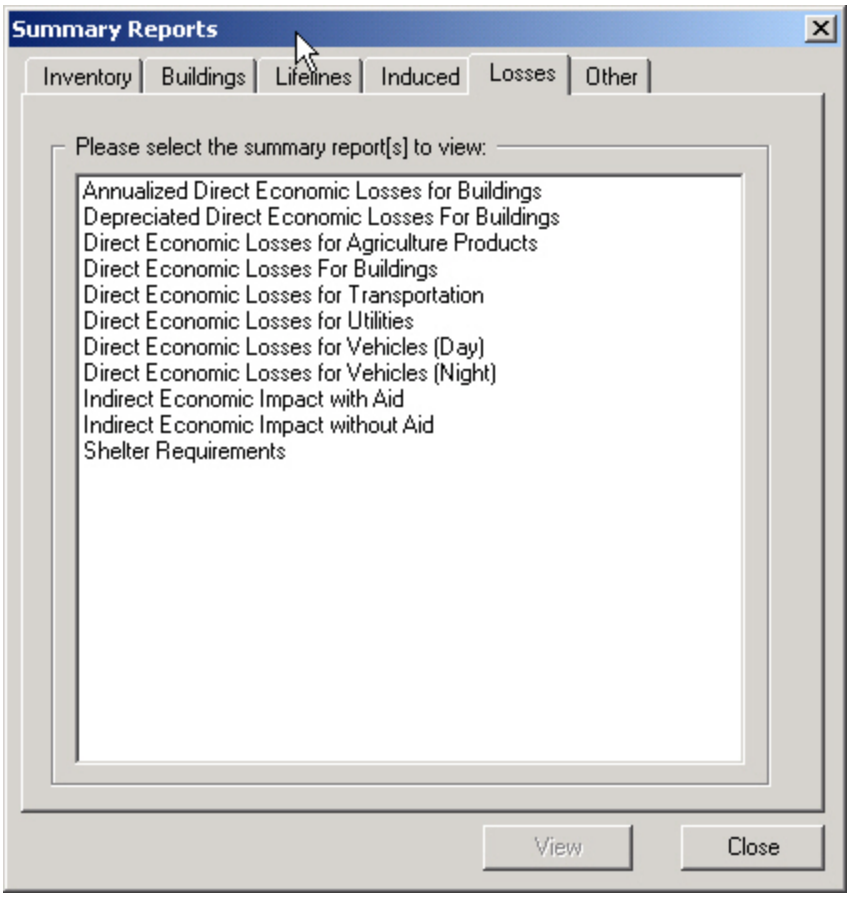


Figure 11.7 Summary Reports Dialog

Crystal Reports must be installed (comes with ArcView) for this option to be available.

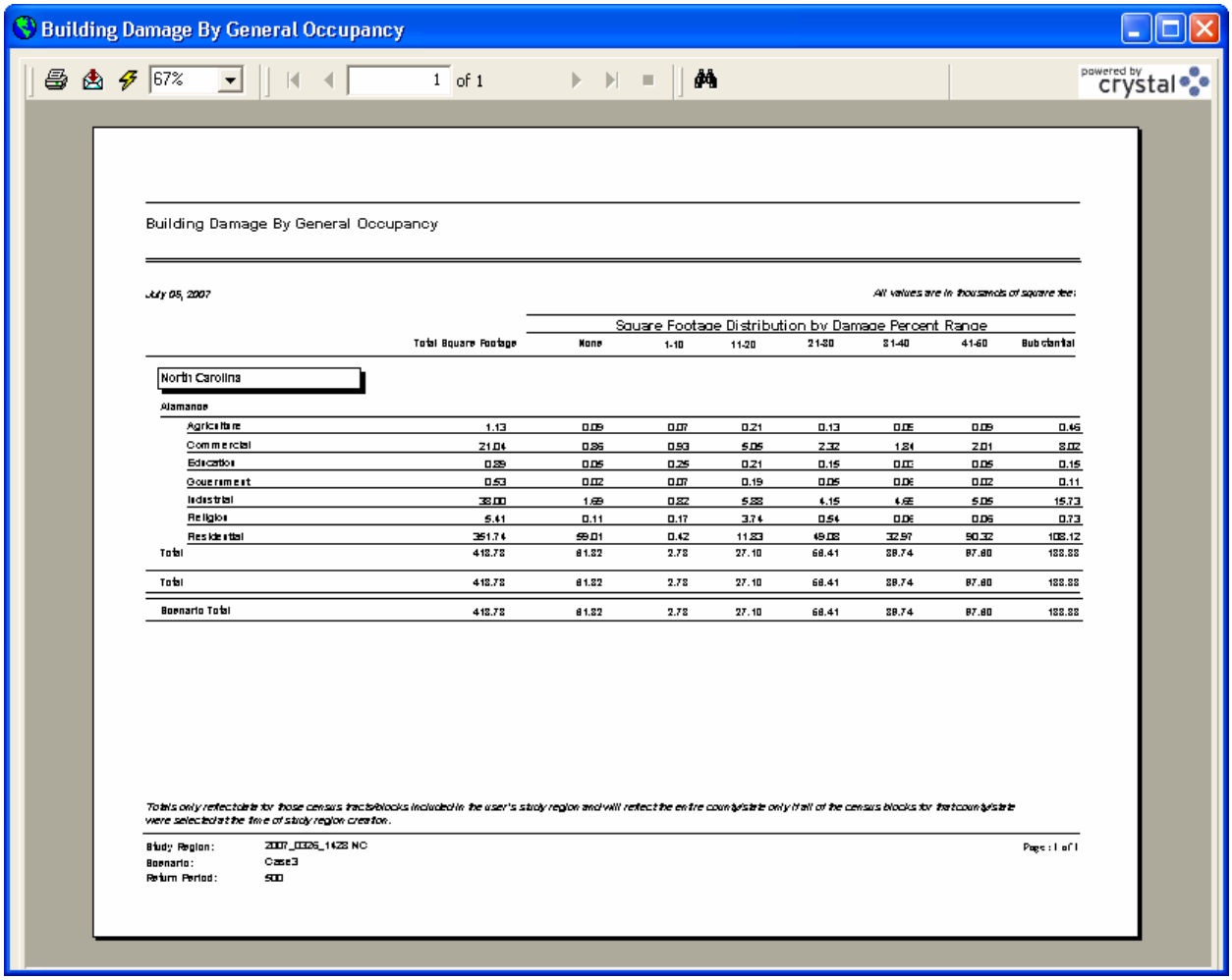

Building Damage By General Occupancy
67%
1 of 1
powered by crystal
Building Damage By General Occupancy
July 05, 2007
All values are in thousands of square feet
Square Footage Distribution by Damage Percent Range
Total Square Footage
None
1-10
11-20
21-30
31-40
41-60
Substantial
North Carolina
Alamance
Agriculture 1.13 0.09 0.07 0.21 0.13 0.05 0.09 0.46
Commercial 21.04 0.86 0.93 5.05 2.32 1.84 2.01 8.02
Education 0.89 0.05 0.25 0.21 0.15 0.02 0.05 0.15
Government 0.53 0.02 0.07 0.19 0.05 0.05 0.02 0.11
Industrial 38.00 1.69 0.82 5.83 4.15 4.65 5.05 15.73
Religion 5.41 0.11 0.17 3.74 0.54 0.05 0.05 0.73
Residential 351.74 55.01 0.42 11.83 49.08 32.97 50.32 108.12
Total 418.73 81.82 2.73 27.10 56.41 39.74 57.60 133.33
Total 418.73 81.82 2.73 27.10 56.41 39.74 57.60 133.33
Scenario Total 418.73 81.82 2.73 27.10 56.41 39.74 57.60 133.33
Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.
Study Region: 2007_0026_1428 NC
Scenario: Case3
Return Period: 500
Page: 1 of 1

Figure 11.8 Sample Summary Report: Building Damage by General Occupancy

Table 11.1 has a brief description of the different types of reports available.

Table 11.1 List of Summary Reports

Tab	Report	Description
Inventory	Agricultural Products Dollar Exposure	Dollar exposure (in thousands of dollars) of the agricultural products in the study region.
Inventory	Building Stock Dollar Exposure by Building Type	Dollar exposure (in thousands of dollars) of the building stock by building type in the study region.
Inventory	Building Stock Dollar Exposure by Occupancy	Dollar exposure (in thousands of dollars) of the building stock by occupancy in the study region.
Inventory	Transportation Systems Dollar Exposure	Dollar exposure (in thousands of dollars) of the transportation systems in the study region.
Inventory	Utility System Dollar Exposure	Dollar exposure (in thousands of dollars) of the utility system in the study region.
Inventory	Vehicle Dollar Exposure (Day)	Dollar exposure (in thousands of dollars) of vehicles (during the day) in the study region.
Inventory	Vehicle Dollar Exposure (Night)	Dollar exposure (in thousands of dollars) of vehicles (during the night) in the study region.
Buildings	Building Damage by Building Type	Building damage (square footage distribution by percent damage) by building type caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy	Building damage (square footage distribution by percent damage) by general occupancy caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Post-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Pre-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage Count by General Building Type	Building damage (building count by percent damage) by general building type caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy	Building damage (building count by percent damage) by general occupancy caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy (Post-FIRM)	Building damage (building count by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy (Pre-FIRM)	Building damage (building count by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario.

Table 11.1 List of Summary Reports (Continued)

Tab	Report	Description
Buildings	Emergency Operation Center Damage & Functionality	Damage and functionality of Emergency Operation Center caused by the hazard in the scenario.
Buildings	Fire Station Damage & Functionality	Damage and functionality of Fire Stations caused by the hazard in the scenario.
Buildings	Hospital Damage & Functionality	Damage and functionality of Hospitals caused by the hazard in the scenario.
Buildings	Police Station Damage & Functionality	Damage and functionality of Police Stations caused by the hazard in the scenario.
Buildings	School Damage & Functionality	Damage and functionality of Schools caused by the hazard in the scenario.
Lifelines	Highway Bridge Damage & Functionality	Damage and functionality of Highway Bridges caused by the hazard in the scenario.
Lifelines	Light Rail Bridge Damage & Functionality	Damage and functionality of Light Rail Bridges caused by the hazard in the scenario.
Lifelines	Potable Water Facility Damage	Damage to Potable Water Facilities caused by the hazard in the scenario.
Lifelines	Railroad Bridge Damage & Functionality	Damage and functionality of Railroad Bridges caused by the hazard in the scenario.
	Wastewater Facility Damage	Damage to Wastewater Facilities caused by the hazard in the scenario.
Induced	Debris Generated	Estimated total of debris generated (in tons) by the hazard in the scenario.
Losses	Annualized Direct Economic Losses for Buildings	Annualized direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Depreciated Direct Economic Losses for Buildings	Depreciated direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Agricultural Products	Direct economic losses (in thousands of dollars) for agricultural products resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Buildings	Direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Transportation	Direct economic losses (in thousands of dollars) for transportation resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Utilities	Direct economic losses (in thousands of dollars) for utilities resulting from the hazard in the scenario
Losses	Direct Economic Losses for Vehicles (Day)	Direct economic losses (in thousands of dollars for vehicles (during the day) resulting from the hazard in the scenario.

Table 11.1 List of Summary Reports (Continued)

Tab	Report	Description
Losses	Direct Economic Losses for Vehicles (Night)	Direct economic losses (in thousands of dollars) for vehicles (during the night) resulting from the hazard in the scenario.
Losses	Indirect Economic Impact with Aid	Income and Employment impact (in millions of dollars) with outside aid due to the hazard in the scenario.
Losses	Indirect Economic Impact without Aid	Income and Employment impact (in millions of dollars) without outside aid due to the hazard in the scenario.
Losses	Shelter Requirements	Estimated number of households that are expected to be displaced; and of those households, estimated number of people to seek temporary shelter in public shelters due to the hazard in the scenario.
Other	Combined Annualized Loss	Provides the average annualized loss for multi-hazard study regions of their general building stock.
Other	Global Summary Report	Includes general description of the region, building exposure by occupancy type (one for the study region and another for the scenario), expected building damage by occupancy and expected building damage by building type, expected damage to essential facilities, debris generated, shelter requirements, building-related economic loss estimates, and regional population and building value data.
Other	Quick Assessment	Includes regional statistics (area in square miles, number of census blocks, number of buildings, number of people in the region, building exposure) and scenario results (shelter requirements and economic loss)

Chapter 12 References

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Gulf Engineers & Consultants (GEC), 1996. "Depth –Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Jefferson and Orleans Flood Control Feasibility Studies", Final Report, prepared by GEC for the USACE New Orleans District.

GEC, 1997. "Depth –Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Mroganza to the Gulf, Louisiana Feasibility Studies" Final Report, Volume I, prepared by GEC for the USACE New Orleans District.

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URS, 1992. "Updated Flood Damage Evaluation Guidelines for the Passaic River Basin Project", prepared by URS Consultants for the USACE New York District.

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U.S. Army Corps of Engineers (USACE), 1984. "Flood Emergency Preparedness System: Passaic River Basin, New Jersey and New York, Detailed Project Report and Environmental Assessment", USACE New York District.

Appendix A. Verifying HAZUS Installation

A.1 Purpose

With the completed installation of **HAZUS**, it is wise to walk through the following section to determine if the installation completed successfully and all of the baseline data is available for use. Following the suggested procedures will demonstrate that the product can successfully generate results immediately. By following the step-by-step procedure below, the user will end up with populated results tables and Crystal summary reports.

A.2 Scope

This verification process will validate only the Flood Model. It does not address installation of any of the other hazards. Since the verification process intent is to show that the user will get the same answer as the development team, the test case has been established as Alamance County, North Carolina for the Riverine analysis and Brunswick County, North Carolina for the Coastal analysis.

A.3 Operations Timing

For the user's reference, in many steps an estimated processing time has been provided such as "…this process may take between 5 and 10 minutes…" although the processing time is extremely dependent on the user's operating system. This information is provided to give the user some indication on what to expect from each operation for this scenario only. For comparison purposes, the timing reported here is based on a personal computer with a 1.8 GHz processor and 1GB of RAM. Your times will either be faster or slower accordingly.

A.4 Study Region Creation Verification Procedure

This section describes the Treaty Reinsurance Module and how it fits into the overall WorldCat Product Line assumes **HAZUS** has been successfully installed. The data path pointers must point to where the DVD data was copied to the hard drive. The region path needs to point to a folder where regions should be created. These steps will demonstrate that a flood study region can be created.

A.4.1 Select "Create a new region"

Start **HAZUS**. Use the region wizard to create a study region.

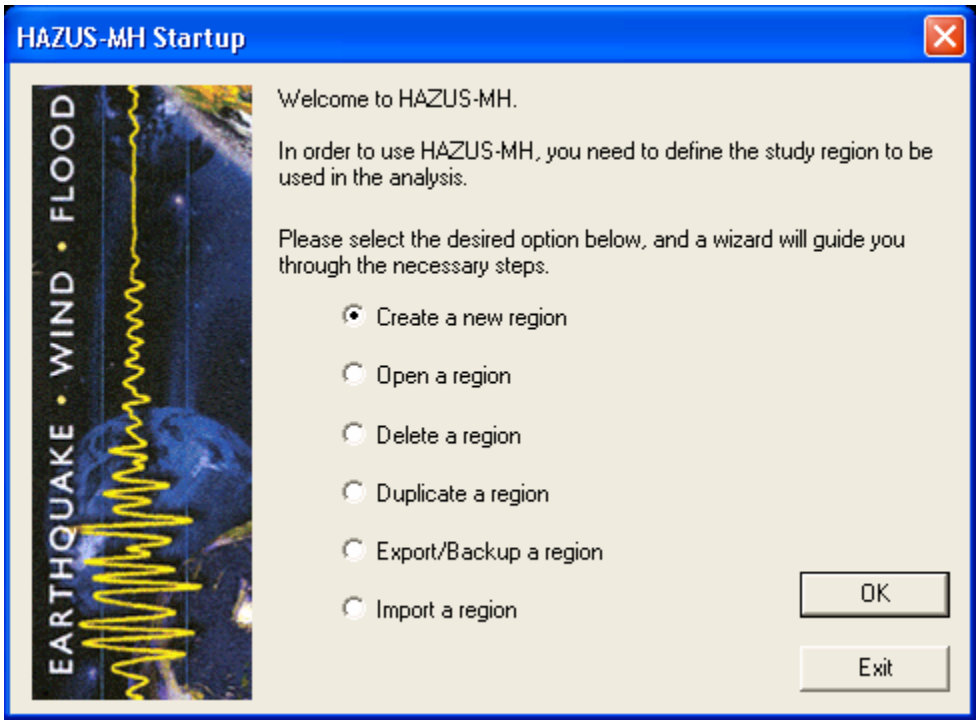

HAZUS-MH Startup
EARTHQUAKE • WIND • FLOOD
Welcome to HAZUS-MH.
In order to use HAZUS-MH, you need to define the study region to be used in the analysis.
Please select the desired option below, and a wizard will guide you through the necessary steps.
Create a new region
Open a region
Delete a region
Duplicate a region
Export/Backup a region
Import a region
OK
Exit

Figure A.1 HAZUS Start-up Wizard

A.4.1.1 Enter a Name

Users may want to set up their study region names that will allow things to naturally order themselves. It is suggested the user us the format YYYY-MMDD-HHMM ST. For example this verification model was done: 2:28 PM Mar 26 in North Carolina. The county for the verification procedure is Alamance County for riverine and Brunswick County for Coastal.

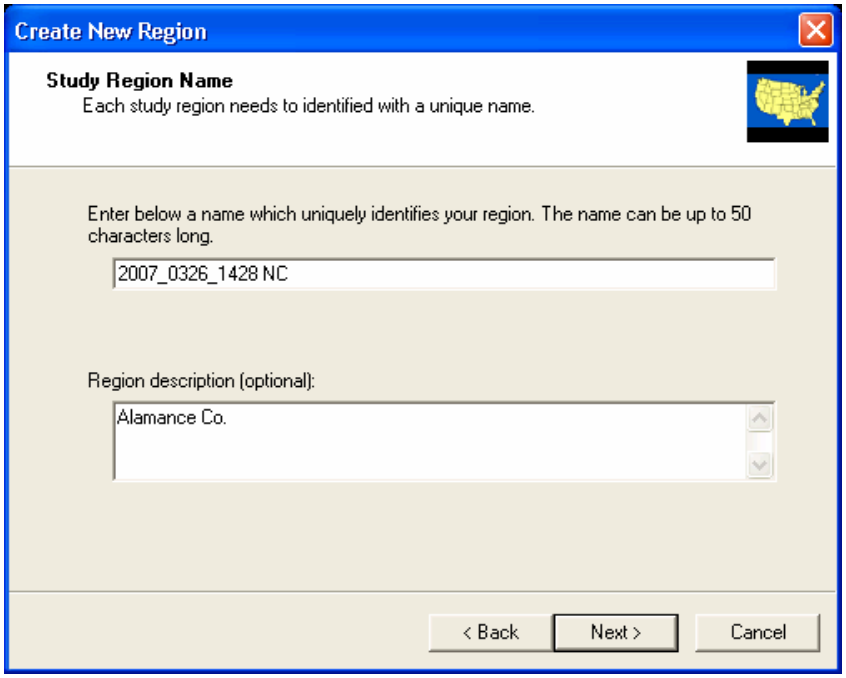

Create New Region
Study Region Name
Each study region needs to identified with a unique name.
Enter below a name which uniquely identifies your region. The name can be up to 50 characters long.
2007_0326_1428 NC
Region description (optional):
Alamance Co.
< Back
Next >
Cancel

Figure A.2 Inputting the HAZUS Study Region Name

A.4.1.2 Select Flood Hazard

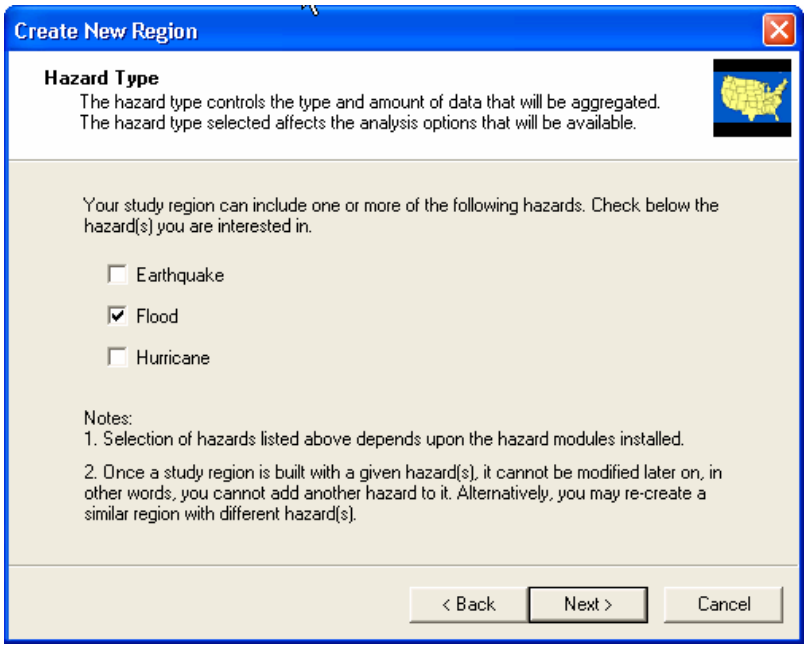

Create New Region
Hazard Type
The hazard type controls the type and amount of data that will be aggregated.
The hazard type selected affects the analysis options that will be available.
Your study region can include one or more of the following hazards. Check below the hazard(s) you are interested in.
Earthquake
Flood
Hurricane
Notes:
1. Selection of hazards listed above depends upon the hazard modules installed.
2. Once a study region is built with a given hazard(s), it cannot be modified later on, in other words, you cannot add another hazard to it. Alternatively, you may re-create a similar region with different hazard(s).
< Back
Next >
Cancel

Figure A.3 Selecting a Hazard Model in the HAZUS Start-up Wizard

A.4.2 Select Aggregation at County Level

A.4.2.1 Select North Carolina

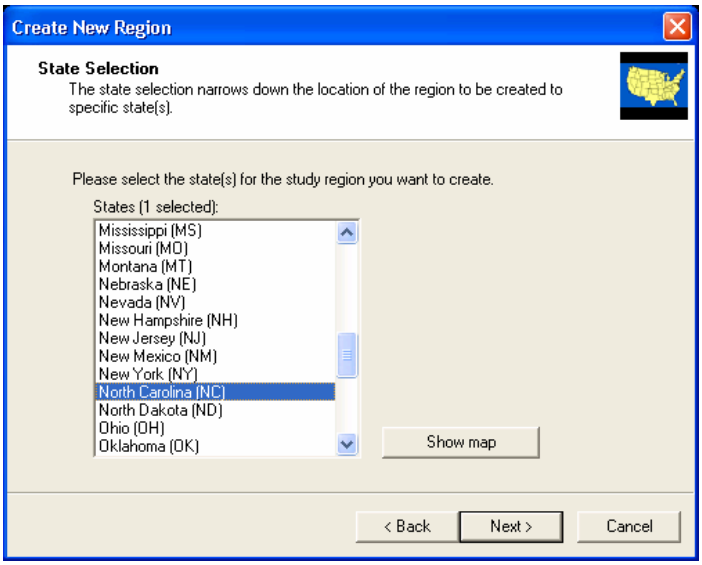


Figure A.4 Selecting the Study Region State in the HAZUS Start-up Wizard

A.4.2.2 Select Alamance County (Riverine)

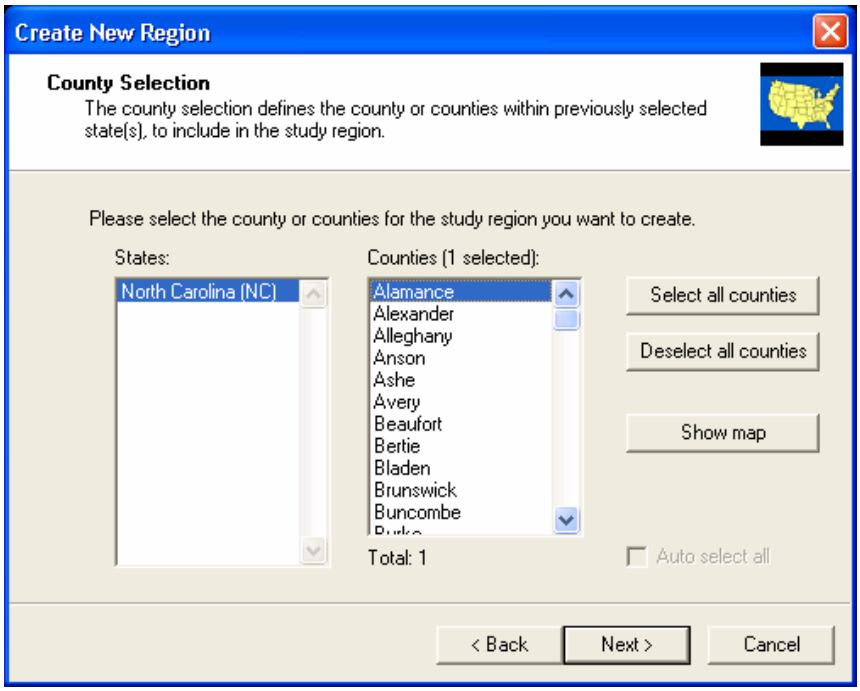


Figure A.5 Selecting the Study Region County in the HAZUS Start-up Wizard

A.4.2.3 Select Brunswick County (Coastal)

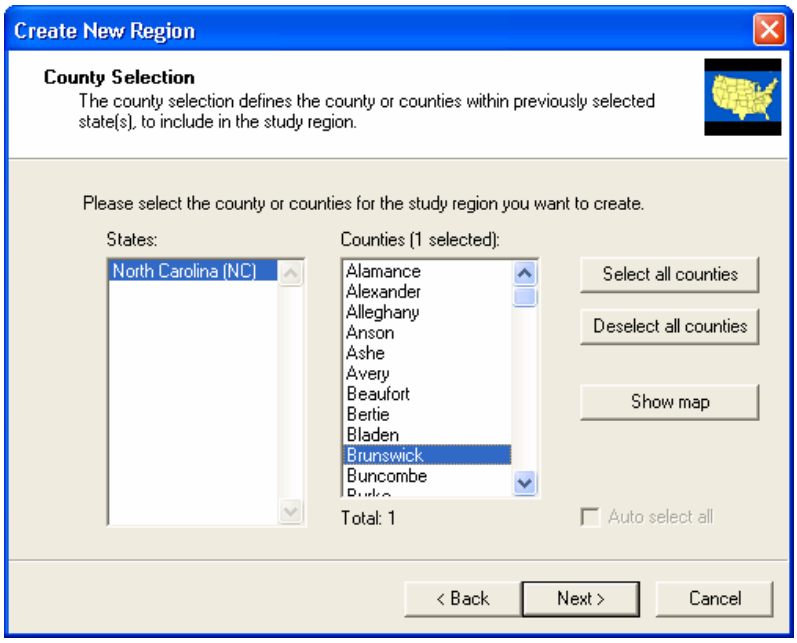


Figure A.6 Selecting the Study Region County in the HAZUS Start-up Wizard

A.4.2.4 Wait for Region to be created

Completing the selection process in the Start-up Wizard, the user will select **Finish** and a progress bar will be displayed as the **HAZUS** "shell" will aggregate the baseline data and import the data into the study region database. When completed, the user should see a folder with the study region name created underneath the folder where regions are kept (in this case C:\Program Files_Regions). There will be a large number of files in that folder, but there are three files of interest: to the user in this verification process

HazusFl.mxd: This file should have a time stamp of roughly 6-8 minutes later than whatever time the region creation process was started and be approximately 190 KB in size.

DTSLog.txt: This file contains the **HAZUS** shell's log of the creation process. Should anything not work properly, this will be a key file to examine and this will be one of the files the product support team will request from the user.

flDtsLog.txt: This file contains the creation process log for the flood model and the unique databases and components associated with the model. Should anything not work properly, this will be a key file to examine and this will be one of the files the product support team will request from the user.

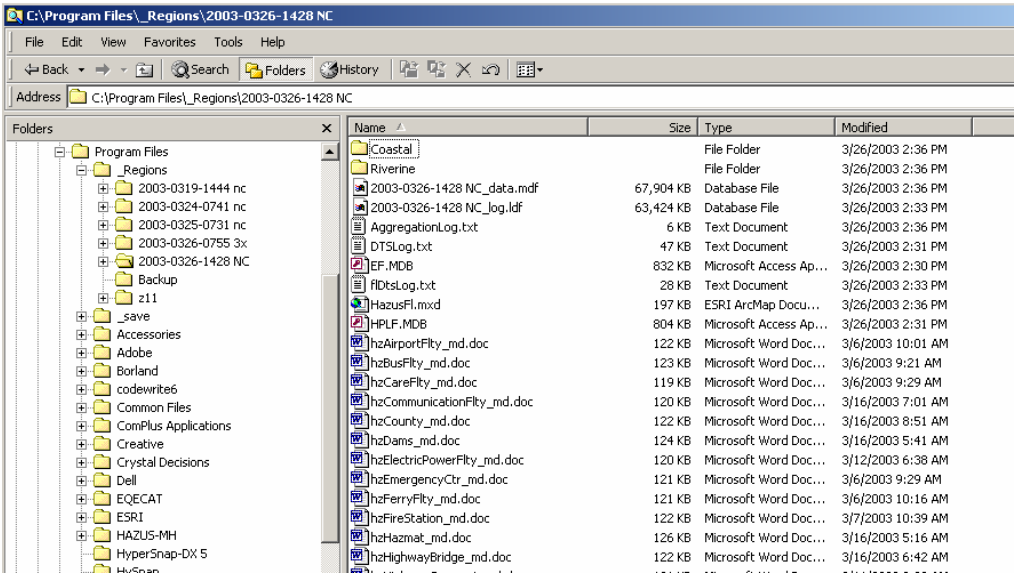

C:\Program Files_Regions\2003-0326-1428 NC
File Edit View Favorites Tools Help
Back Search Folders History
Address C:\Program Files_Regions\2003-0326-1428 NC
Folders
Program Files
_Regions
2003-0319-1444 nc
2003-0324-0741 nc
2003-0325-0731 nc
2003-0326-0755 3x
2003-0326-1428 NC
Backup
z11
_save
Accessories
Adobe
Borland
codewrite6
Common Files
ComPlus Applications
Creative
Crystal Decisions
Dell
EQECAT
ESRI
HAZUS-MH
HyperSnap-DX 5
Name Size Type Modified
Coastal File Folder 3/26/2003 2:36 PM
Riverine File Folder 3/26/2003 2:36 PM
2003-0326-1428 NC_data.mdf 67,904 KB Database File 3/26/2003 2:36 PM
2003-0326-1428 NC_log.ldf 63,424 KB Database File 3/26/2003 2:33 PM
AggregationLog.txt 6 KB Text Document 3/26/2003 2:36 PM
DTSLog.txt 47 KB Text Document 3/26/2003 2:31 PM
EF.MDB 832 KB Microsoft Access Ap... 3/26/2003 2:30 PM
flDtsLog.txt 28 KB Text Document 3/26/2003 2:33 PM
HazusFl.mxd 197 KB ESRI ArcMap Docu... 3/26/2003 2:36 PM
HPLF.MDB 804 KB Microsoft Access Ap... 3/26/2003 2:31 PM
hzAirportFlty_md.doc 122 KB Microsoft Word Doc... 3/6/2003 10:01 AM
hzBusFlty_md.doc 123 KB Microsoft Word Doc... 3/6/2003 9:21 AM
hzCareFlty_md.doc 119 KB Microsoft Word Doc... 3/6/2003 9:29 AM
hzCommunicationFlty_md.doc 120 KB Microsoft Word Doc... 3/16/2003 7:01 AM
hzCounty_md.doc 122 KB Microsoft Word Doc... 3/16/2003 8:51 AM
hzDams_md.doc 124 KB Microsoft Word Doc... 3/16/2003 5:41 AM
hzElectricPowerFlty_md.doc 120 KB Microsoft Word Doc... 3/12/2003 6:38 AM
hzEmergencyCtr_md.doc 121 KB Microsoft Word Doc... 3/6/2003 9:29 AM
hzFerryFlty_md.doc 121 KB Microsoft Word Doc... 3/6/2003 10:16 AM
hzFireStation_md.doc 122 KB Microsoft Word Doc... 3/7/2003 10:39 AM
hzHazmat_md.doc 126 KB Microsoft Word Doc... 3/16/2003 5:16 AM
hzHighwayBridge_md.doc 122 KB Microsoft Word Doc... 3/16/2003 6:42 AM

Figure A.7 Snapshot of the HAZUS Flood Model Study Region Files and Folders

A.4.3 Study Region Open Verification Procedure

The following sections will allow the user to demonstrate that a flood study region can be opened and that the correct version of the flood model is installed.

A.4.3.1 Open the New Region

When the creation process ended and the progress and creation dialogs have closed the region wizard dialog should remain on screen as shown in Figure A.8 below. Select "Open a region" option button and click **OK**.

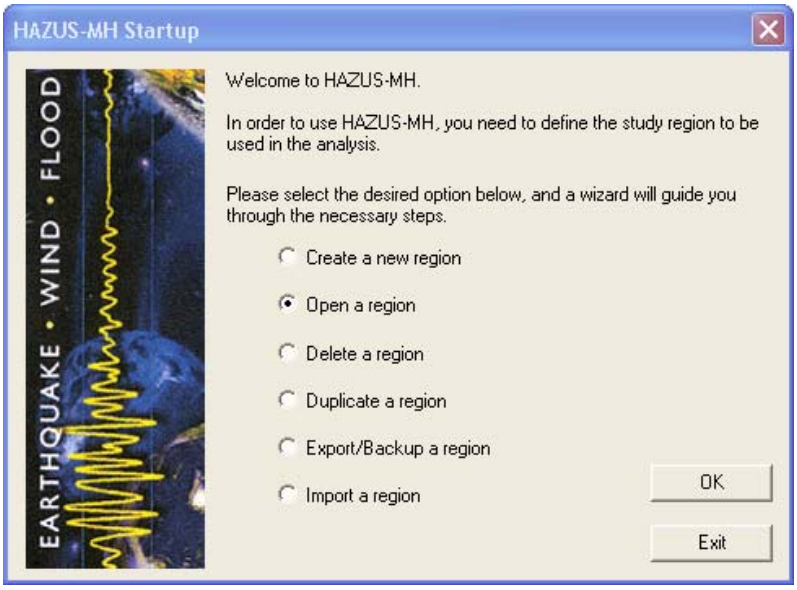

HAZUS-MH Startup
EARTHQUAKE • WIND • FLOOD
Welcome to HAZUS-MH.
In order to use HAZUS-MH, you need to define the study region to be used in the analysis.
Please select the desired option below, and a wizard will guide you through the necessary steps.
Create a new region
Open a region
Delete a region
Duplicate a region
Export/Backup a region
Import a region
OK
Exit

Figure A.8 Opening the Flood Model through the HAZUS Study Region Wizard

A.4.3.2 Open the New Region

Figure A.9 shows the dialog where the user can select a study region to open. The dialog should display any study regions created by the user. As this process is intended to occur after the user has just completed installation of the software and created their first study region, this dialog should have only one region for selection. Figure A.9 shows how the dialog will appear should the user have created several regions. Figure A.10 shows the same selection with the coastal region in the list of regions to select from. Highlight the study region and select **Next**.

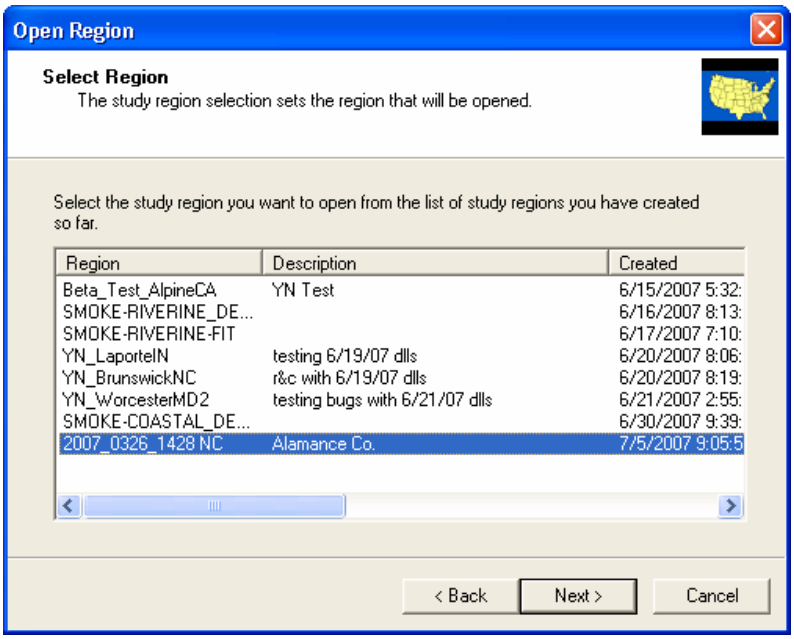


Figure A.9 Riverine Study Region Selection in the HAZUS Study Region Wizard

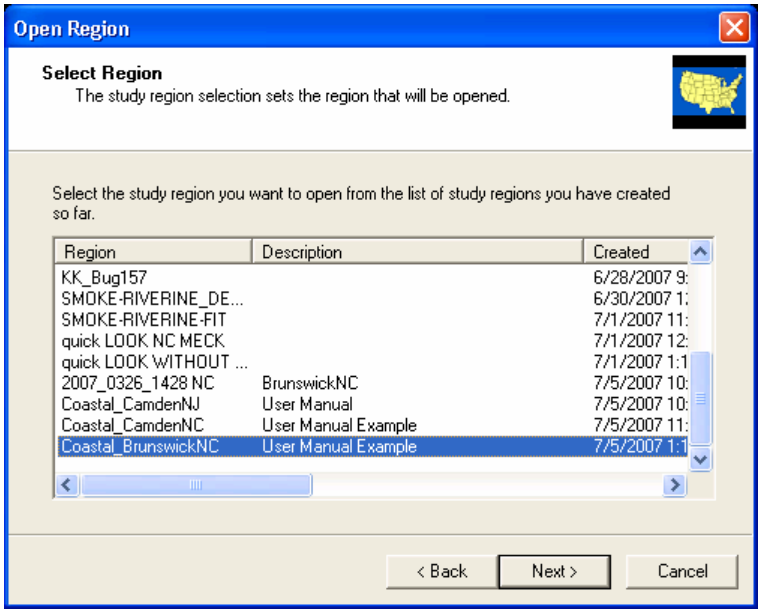


Figure A.10 Coastal Study Region Selection in the HAZUS Study Region Wizard

A.4.3.3 Initial Display

Figure A.11 shows how the Alamance County (riverine verification) study region should appear when opened. Ensure that the study region name is in the title bar, menu items: Inventory, Hazard, Analysis, and Results exist in the toolbar, and that the three layers boundary, tract, and block have loaded in the ArcMap table of contents.

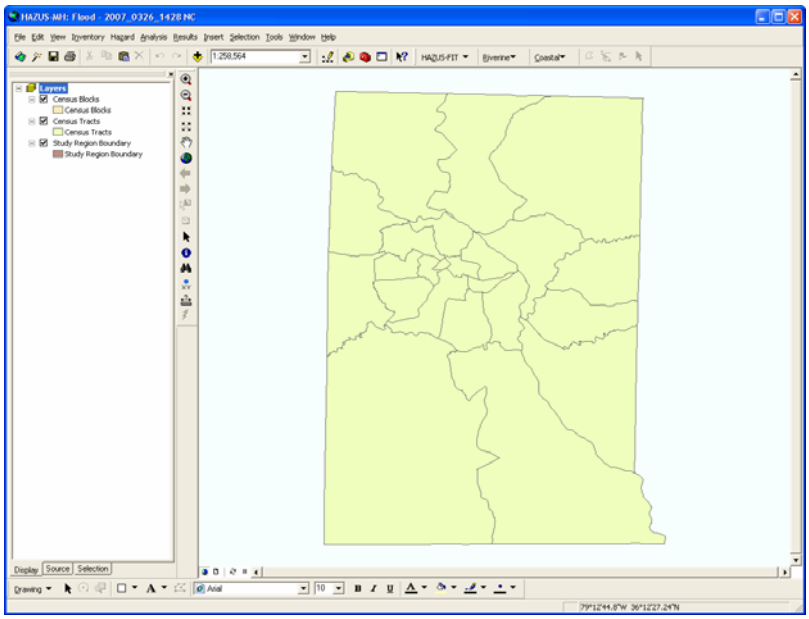


Figure A.11 Alamance County as Seen in the HAZUS Flood Model

Figure A.12 shows how the Brunswick County (Coastal verification) study region should appear when opened. Ensure that the study region name is in the title bar, menu items: Inventory, Hazard, Analysis, and Results exist in the toolbar, and that the layers boundary, tract, block, and Region Shore have been loaded in the ArcMap table of contents.

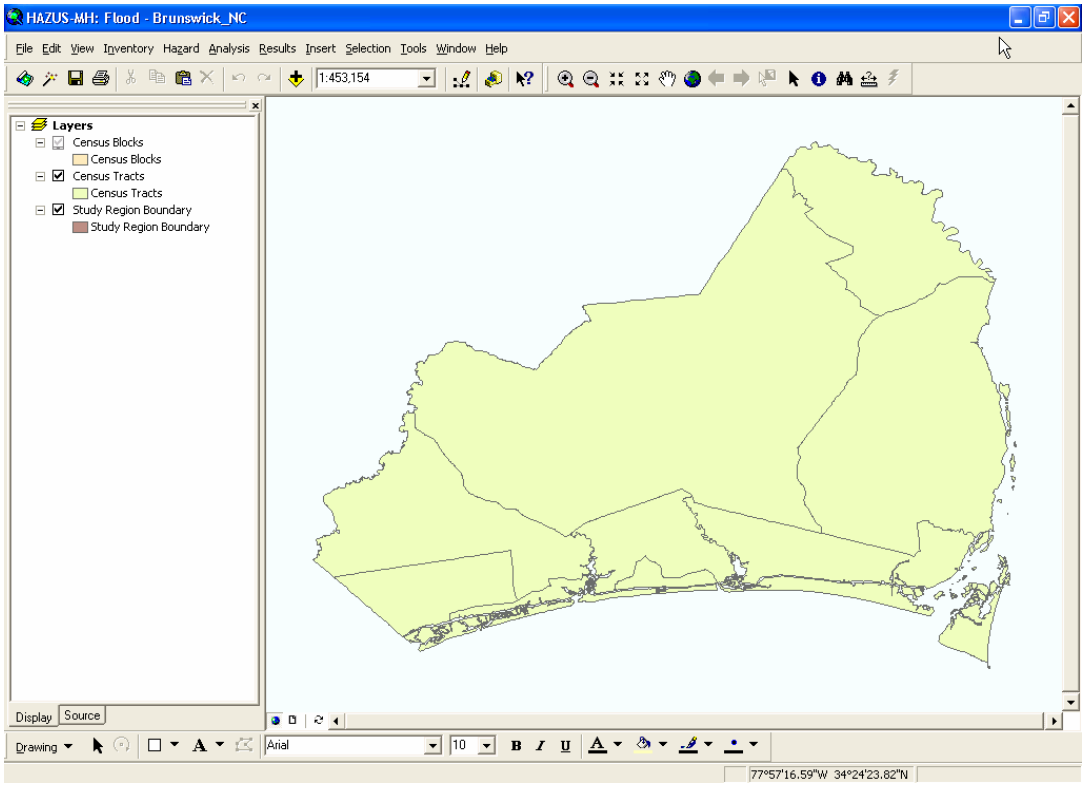


Figure A.12 Brunswick County as Seen in the HAZUS Flood Model

A.4.3.4 Version Check

The first step will be to ensure the version is correct. Use menu *Help\About HAZUS-MH* and verify this displays:

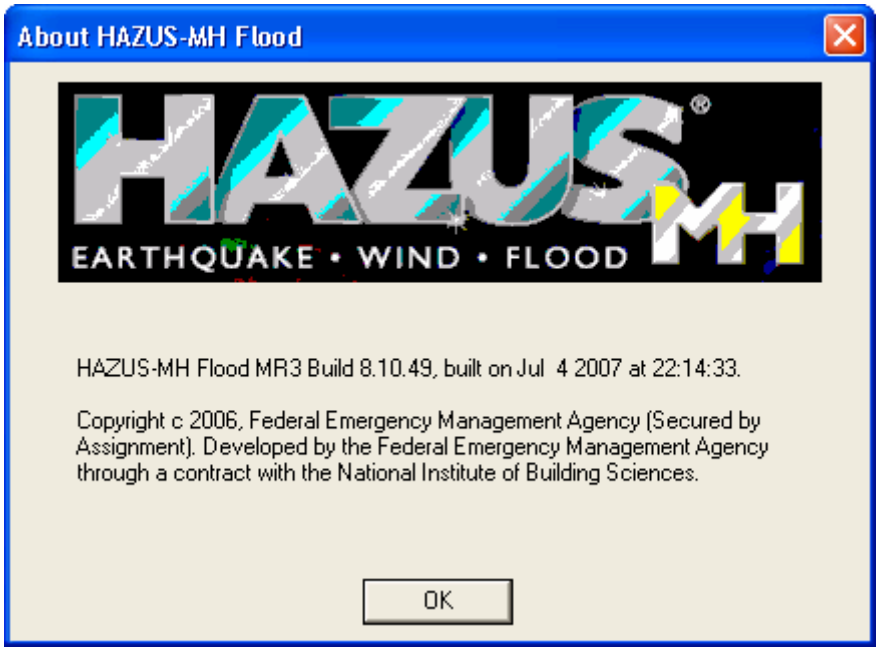

About HAZUS-MH Flood
HAZUS
MH
EARTHQUAKE • WIND • FLOOD
HAZUS-MH Flood MR3 Build 8.10.49, built on Jul 4 2007 at 22:14:33.
Copyright c 2006, Federal Emergency Management Agency (Secured by Assignment). Developed by the Federal Emergency Management Agency through a contract with the National Institute of Building Sciences.
OK

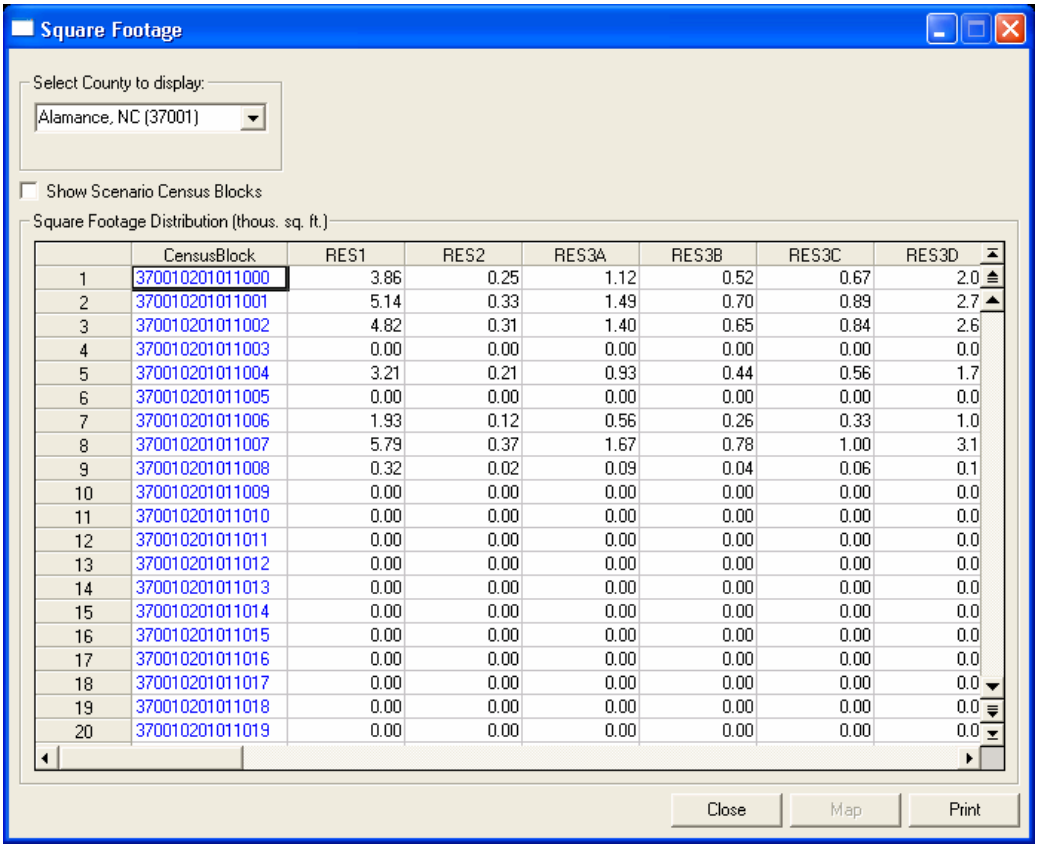
Figure A.13 HAZUS Flood Model Version in Help/About

A.4.4 Inventory Verification

These steps will demonstrate that the Inventory menu items are functional and that inventory and certain occupancy mapping data were created.

A.4.4.1 General Build Stock Check

Use menu item *Inventory\General Building Stock\Square Footage* and ensure this displays.

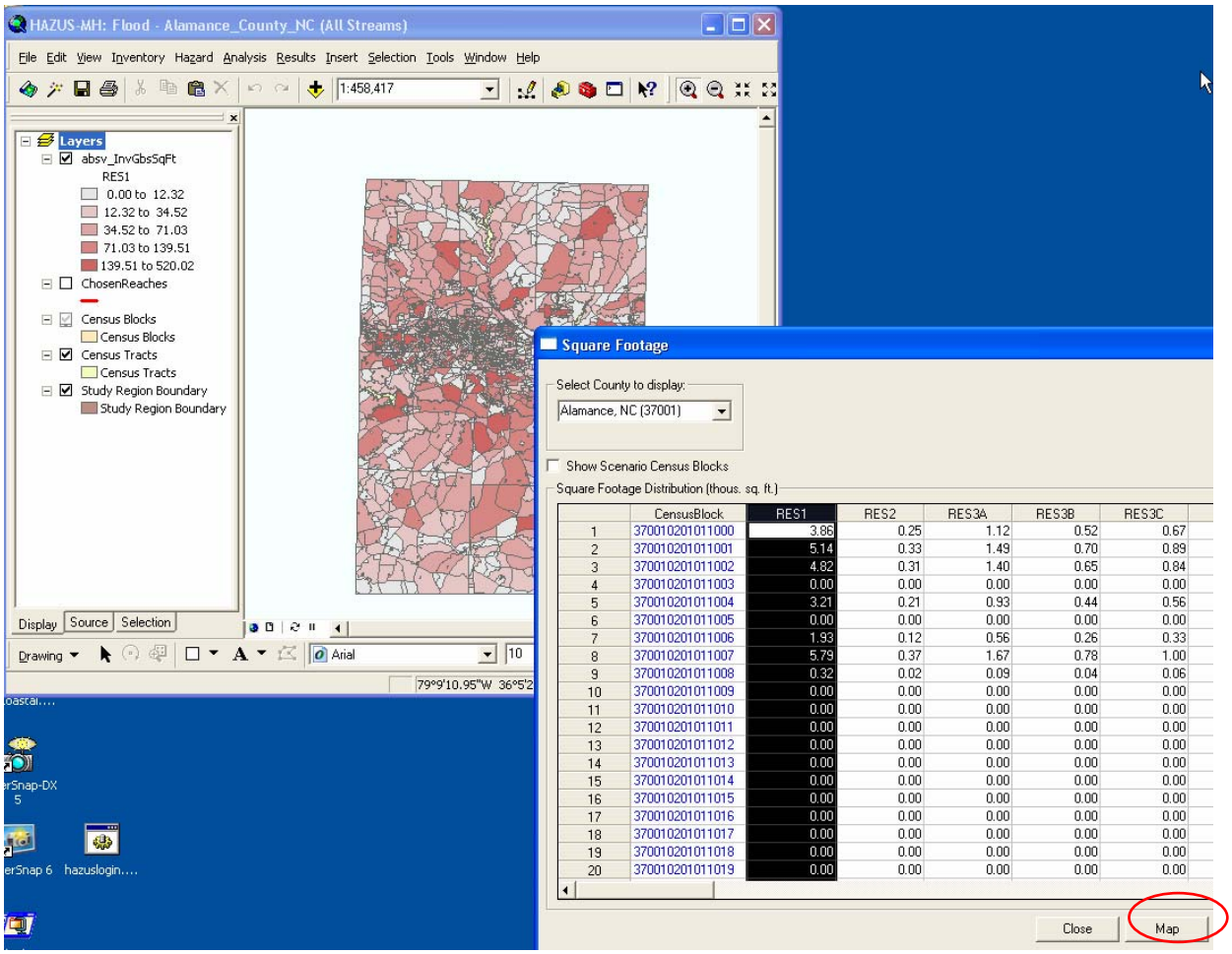


	CensusBlock	RES1	RES2	RES3A	RES3B	RES3C	RES3D
1	370010201011000	3.86	0.25	1.12	0.52	0.67	2.0
2	370010201011001	5.14	0.33	1.49	0.70	0.89	2.7
3	370010201011002	4.82	0.31	1.40	0.65	0.84	2.6
4	370010201011003	0.00	0.00	0.00	0.00	0.00	0.0
5	370010201011004	3.21	0.21	0.93	0.44	0.56	1.7
6	370010201011005	0.00	0.00	0.00	0.00	0.00	0.0
7	370010201011006	1.93	0.12	0.56	0.26	0.33	1.0
8	370010201011007	5.79	0.37	1.67	0.78	1.00	3.1
9	370010201011008	0.32	0.02	0.09	0.04	0.06	0.1
10	370010201011009	0.00	0.00	0.00	0.00	0.00	0.0
11	370010201011010	0.00	0.00	0.00	0.00	0.00	0.0
12	370010201011011	0.00	0.00	0.00	0.00	0.00	0.0
13	370010201011012	0.00	0.00	0.00	0.00	0.00	0.0
14	370010201011013	0.00	0.00	0.00	0.00	0.00	0.0
15	370010201011014	0.00	0.00	0.00	0.00	0.00	0.0
16	370010201011015	0.00	0.00	0.00	0.00	0.00	0.0
17	370010201011016	0.00	0.00	0.00	0.00	0.00	0.0
18	370010201011017	0.00	0.00	0.00	0.00	0.00	0.0
19	370010201011018	0.00	0.00	0.00	0.00	0.00	0.0
20	370010201011019	0.00	0.00	0.00	0.00	0.00	0.0

Figure A.14 Square Foot Occupancy Dialog Validation

A.4.4.2 Shade by Res1

Click on the RES1 column header to select column RES1. The Map button (circled) should become enabled. Press **Map**. A new shaded layer should add to the map and show the distribution of RES1 occupancies. Close the dialog when finished.



	CensusBlock	RES1	RES2	RES3A	RES3B	RES3C
1	370010201011000	3.86	0.25	1.12	0.52	0.67
2	370010201011001	5.14	0.33	1.49	0.70	0.89
3	370010201011002	4.82	0.31	1.40	0.65	0.84
4	370010201011003	0.00	0.00	0.00	0.00	0.00
5	370010201011004	3.21	0.21	0.93	0.44	0.56
6	370010201011005	0.00	0.00	0.00	0.00	0.00
7	370010201011006	1.93	0.12	0.56	0.26	0.33
8	370010201011007	5.79	0.37	1.67	0.78	1.00
9	370010201011008	0.32	0.02	0.09	0.04	0.06
10	370010201011009	0.00	0.00	0.00	0.00	0.00
11	370010201011010	0.00	0.00	0.00	0.00	0.00
12	370010201011011	0.00	0.00	0.00	0.00	0.00
13	370010201011012	0.00	0.00	0.00	0.00	0.00
14	370010201011013	0.00	0.00	0.00	0.00	0.00
15	370010201011014	0.00	0.00	0.00	0.00	0.00
16	370010201011015	0.00	0.00	0.00	0.00	0.00
17	370010201011016	0.00	0.00	0.00	0.00	0.00
18	370010201011017	0.00	0.00	0.00	0.00	0.00
19	370010201011018	0.00	0.00	0.00	0.00	0.00
20	370010201011019	0.00	0.00	0.00	0.00	0.00

Figure A.15 RES1 Square Foot Occupancy Thematic Map

A.4.4.3 General Occupancy Mapping Check

Use menu item *Inventory\General Building Stock\General Occupancy Mapping* and ensure this displays. Close the dialog when finished.

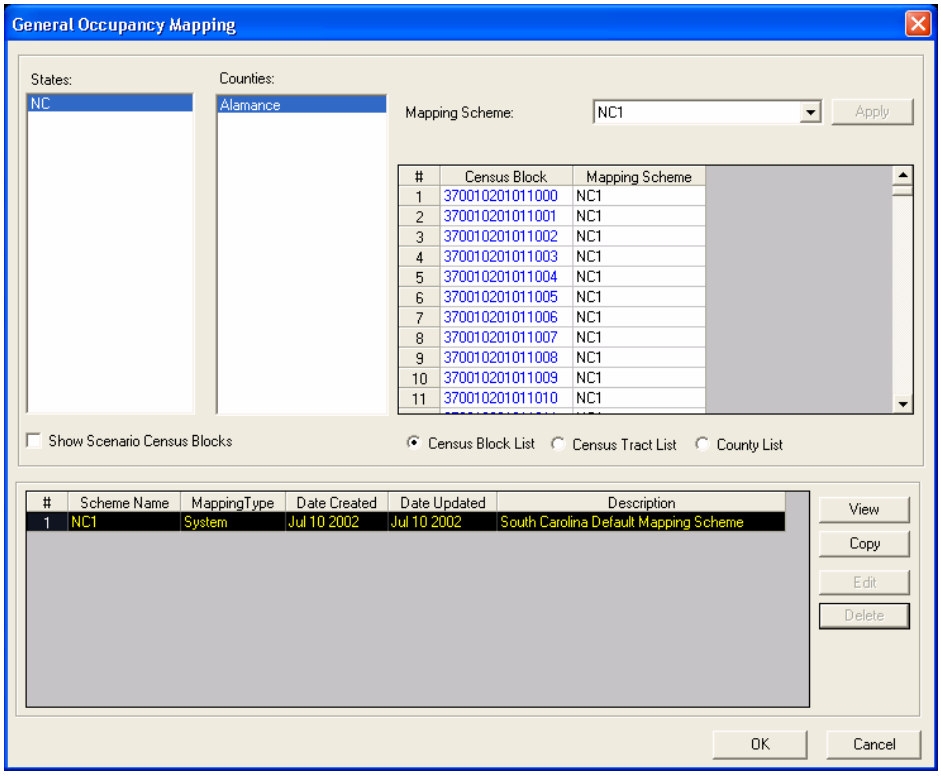


Figure A.16 General Occupancy Mapping Scheme Dialog

A.4.4.4 Flood Occupancy Mapping Check

Use menu item *Inventory\General Building Stock\Flood Specific Occupancy Mapping* and ensure this displays. Each study region will have three default occupancy mapping schemes: Coastal, Great Lakes and riverine. The block type defines whether the census block is assigned the coastal, Great Lakes or riverine default.

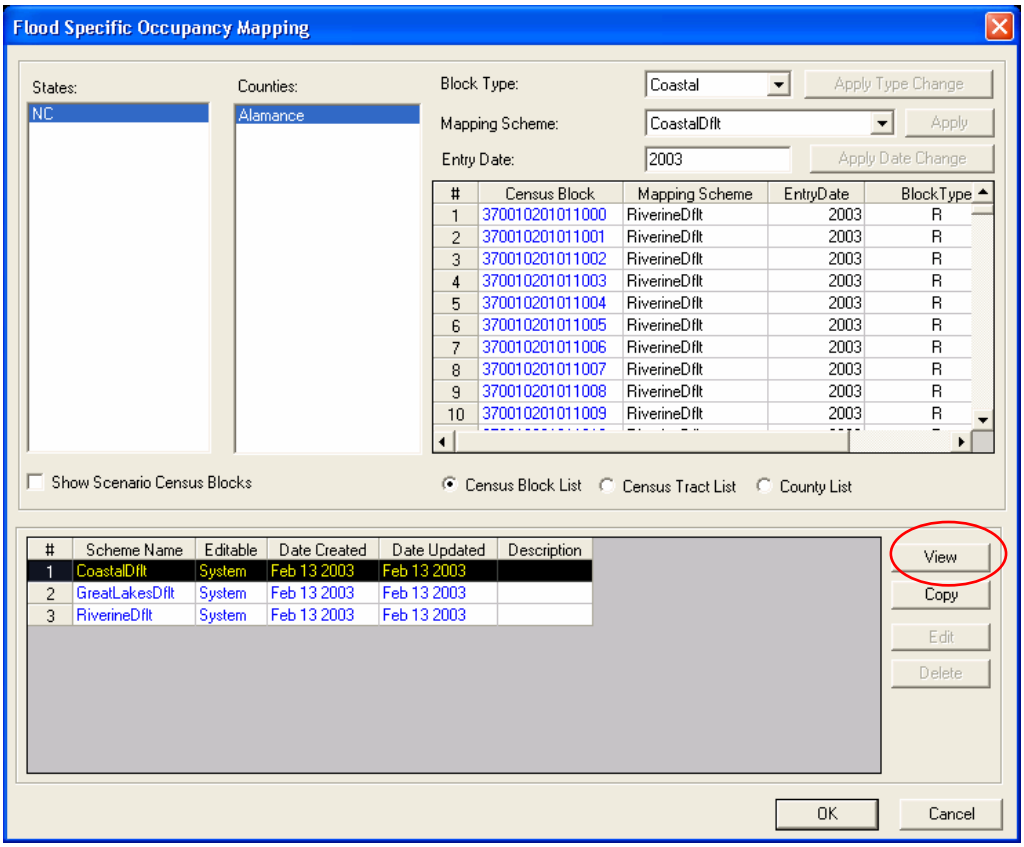


Figure A.17 Flood Occupancy Mapping Scheme Dialog

A.4.4.5 Flood Occupancy Details Check

Select the third row in the lower grid. The first row may appear to be highlighted at the same time. Press the **View** button (circled), expand the tree on the left, select RES1, and ensure the image in Figure A.18 displays. Close the dialog when finished (**OK** or **Cancel**) to return to the Flood Specific Occupancy Mapping scheme dialog.

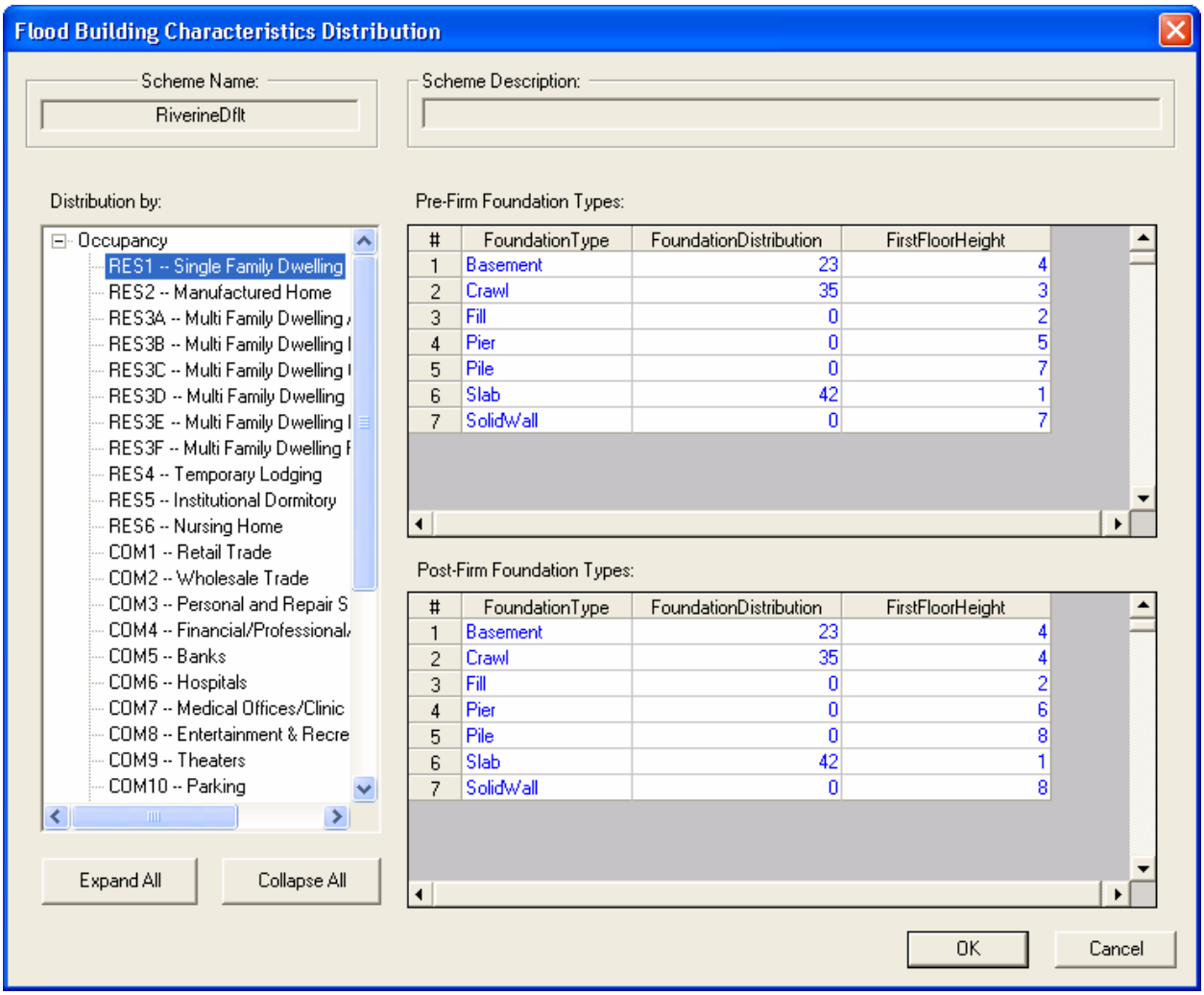


Figure A.18 Riverine Default Flood Occupancy Mapping Scheme Details Dialog

Select the first row in the lower grid. Press the view button (Figure A.17 circled button), expand the tree on the left and select RES1, and ensure the view in Figure A.19 displays. Close the dialog (**OK** or **Cancel**) when finished and close the flood-mapping dialog.

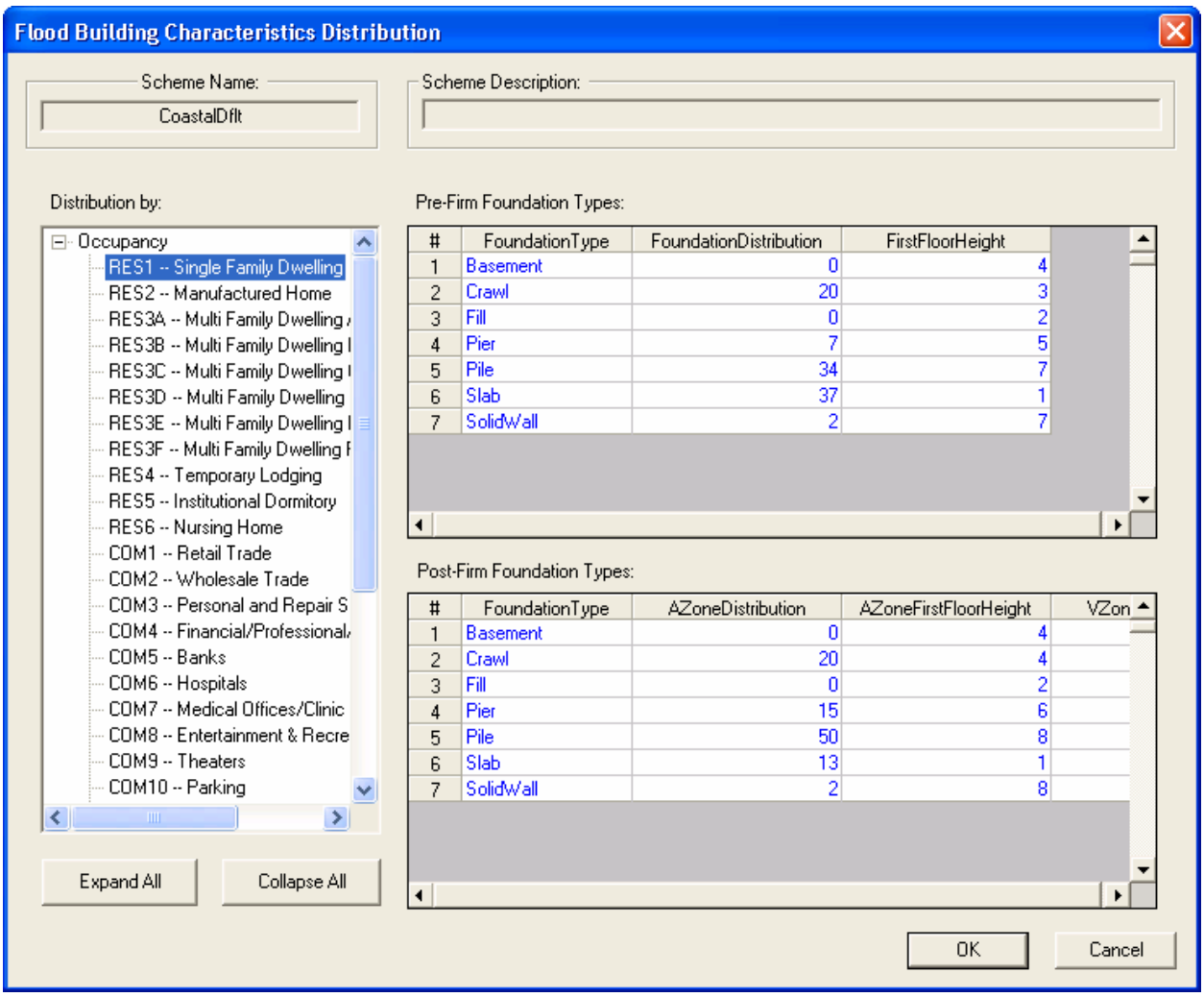


Figure A.19 Coastal Default Flood Occupancy Mapping Scheme Details Dialog

Use menu item *Inventory\General Building Stock\Building Import Tool (BIT)* and ensure this displays. There is no reason to run BIT at this time. Close the dialog when finished. This completes the checks on the GBS menu.

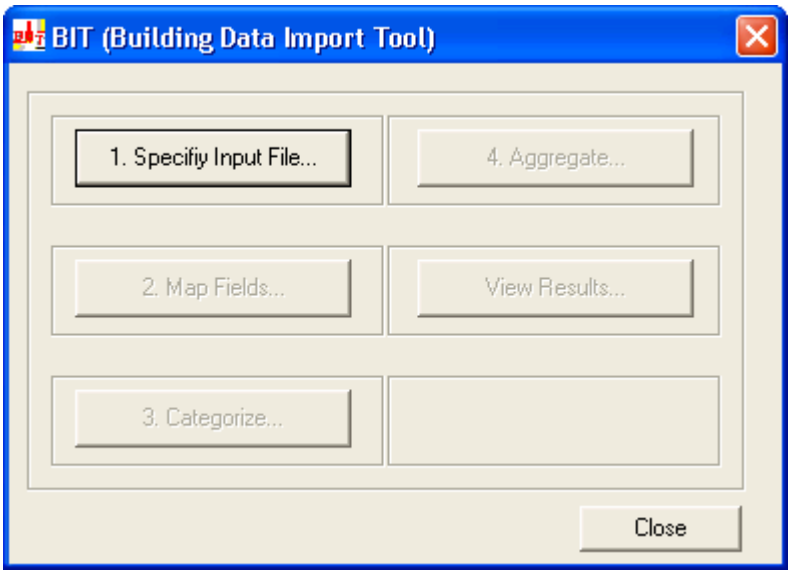


Figure A.20 Building Import Tool (BIT) Launch Dialog

A.4.4.6 Essential Facilities Check

For the next step it will be useful to turn off the RES1 map layer from the table of contents. This can be done by un-checking the show layer button, or highlight the layer name and use the right mouse button (right click) to remove the layer from the table of contents – remove is the second option on the pop-up menu. Then use menu item *Inventory\Essential Facilities*, then click on the Schools tab, and ensure this displays.

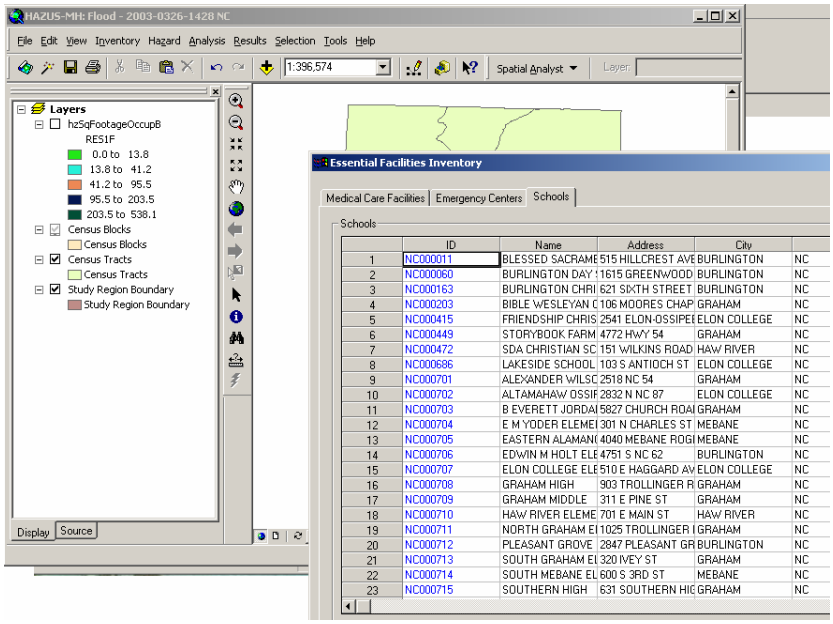

HAZUS-MH: Flood - 2003-0326-1428 NC
File Edit View Inventory Hazard Analysis Results Selection Tools Help
1:396,574
Spatial Analyst
Layer:
Layers
hzSqFootageOccupB
RES1F
0.0 to 13.8
13.8 to 41.2
41.2 to 95.5
95.5 to 203.5
203.5 to 538.1
Census Blocks
Census Blocks
Census Tracts
Census Tracts
Study Region Boundary
Study Region Boundary
Display
Source
Essential Facilities Inventory
Medical Care Facilities
Emergency Centers
Schools
Schools
ID
Name
Address
City
1 NC000011 BLESSED SACRAME 515 HILLCREST AVE BURLINGTON NC
2 NC000060 BURLINGTON DAY S 1615 GREENWOOD BURLINGTON NC
3 NC000163 BURLINGTON CHRI 621 SIXTH STREET BURLINGTON NC
4 NC000203 BIBLE WESLEYAN C 106 MOORES CHAP GRAHAM NC
5 NC000415 FRIENDSHIP CHRIS 2541 ELON-OSSIPEE ELON COLLEGE NC
6 NC000449 STORYBOOK FARM 4772 HWY 54 GRAHAM NC
7 NC000472 SDA CHRISTIAN SC 151 WILKINS ROAD HAW RIVER NC
8 NC000686 LAKESIDE SCHOOL 103 S ANTIOCH ST ELON COLLEGE NC
9 NC000701 ALEXANDER WILSC 2518 NC 54 GRAHAM NC
10 NC000702 ALTAMAHAW OSSIF 2832 N NC 87 ELON COLLEGE NC
11 NC000703 B EVERETT JORDAI 5827 CHURCH ROA GRAHAM NC
12 NC000704 E M YODER ELEME 301 N CHARLES ST MEBANE NC
13 NC000705 EASTERN ALAMAN 4040 MEBANE ROG MEBANE NC
14 NC000706 EDWIN M HOLT ELE 4751 S NC 62 BURLINGTON NC
15 NC000707 ELON COLLEGE ELE 510 E HAGGARD AV ELON COLLEGE NC
16 NC000708 GRAHAM HIGH 903 TROLLINGER R GRAHAM NC
17 NC000709 GRAHAM MIDDLE 311 E PINE ST GRAHAM NC
18 NC000710 HAW RIVER ELEME 701 E MAIN ST HAW RIVER NC
19 NC000711 NORTH GRAHAM EI 1025 TROLLINGER I GRAHAM NC
20 NC000712 PLEASANT GROVE 2847 PLEASANT GR BURLINGTON NC
21 NC000713 SOUTH GRAHAM EL 320 IVEY ST GRAHAM NC
22 NC000714 SOUTH MEBANE EL 600 S 3RD ST MEBANE NC
23 NC000715 SOUTHERN HIGH 631 SOUTHERN HIG GRAHAM NC

Figure A.21 Essential Facilities Dialog Displaying the Schools Tab

A.4.4.7 Plot the Schools

The **Map** button should be automatically enabled. Press **Map** (circled) and a new point layer should add to the map and show the placement of schools. Close the dialog when finished.

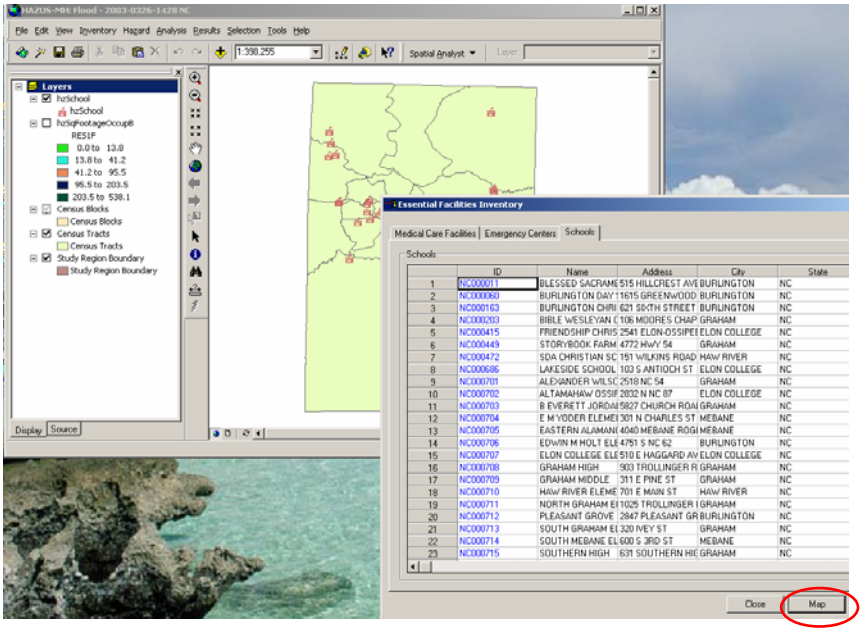


Figure A.22 Mapped Schools for Alamance County

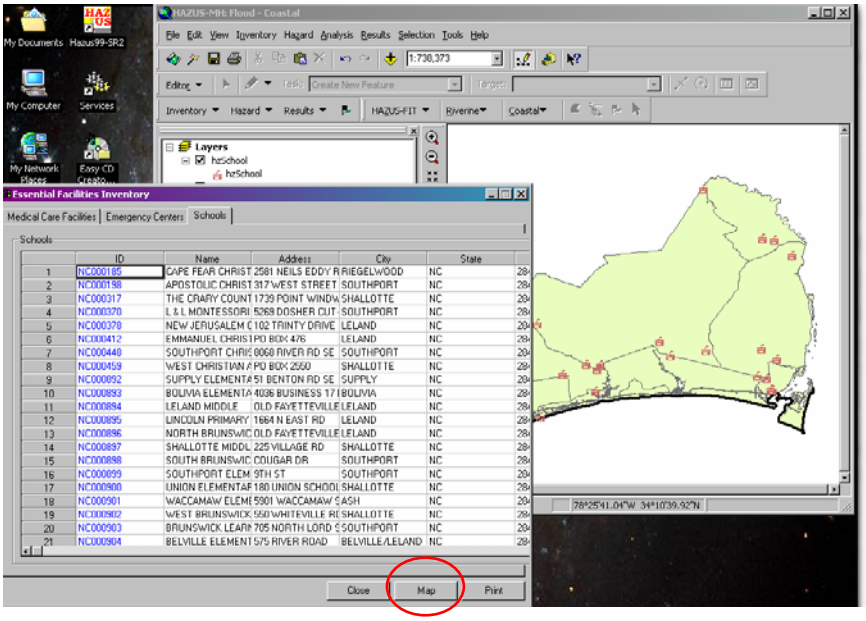


Figure A.23 Mapped Schools for Brunswick County

A.4.4.8 Classification Check

Use menu item *Inventory\View Classification\Buildings and Facilities* and ensure this displays. Close the dialog when finished. This completes the Inventory

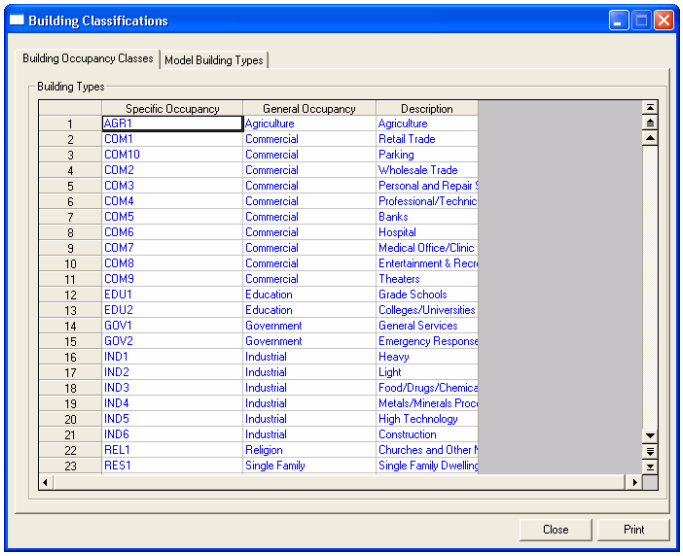


Figure A.24 View Classifications Dialog

A.4.5 Determine Flood Hazard Type

The first submenu item on the Hazard menu is the *Flood Hazard Type*. The selection of the hazard type has a direct impact on the size of the DEM required for the analysis. The riverine analysis requires a DEM that covers the study region and all adjacent watersheds conveying water into the study region, The Coastal analysis requires a DEM that covers the study region and all shorelines available for selection. Selecting "Riverine and Coastal" will create a DEM requirement that satisfies both of the above conditions.

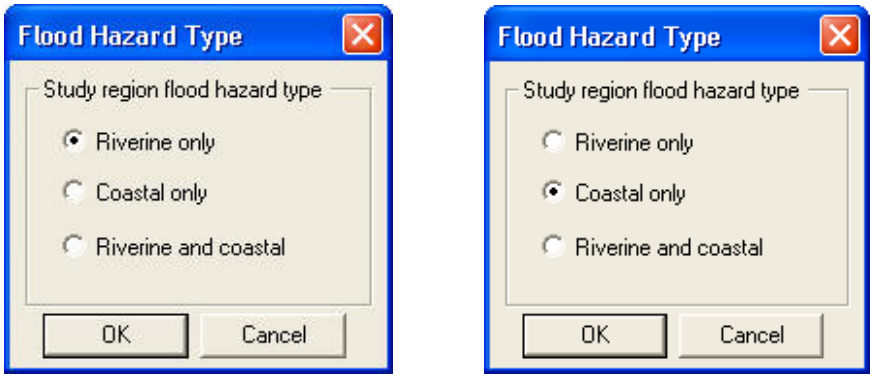


Figure A.25 Select Flood Hazard Type – Riverine for Alamance and Coastal for Brunswick

A.4.6 Determine DEM Coordinates

Use the *Hazard\User Data* menu item and select *Determine required DEM extent* button and ensure this display. Verify all four latitude and longitude numbers are as shown here.

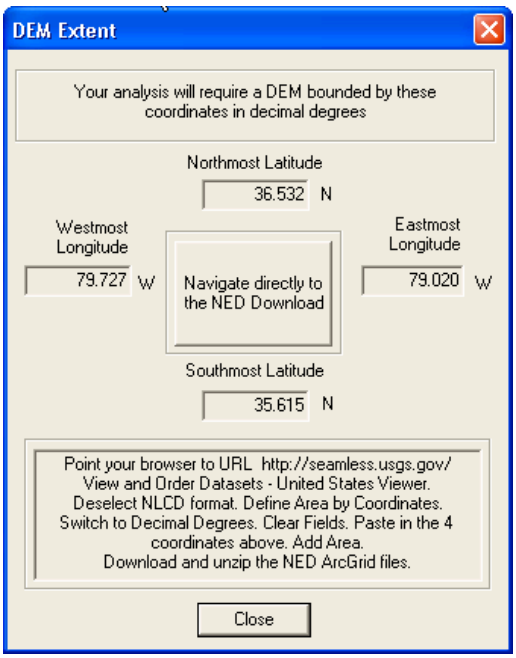

DEM Extent
Your analysis will require a DEM bounded by these coordinates in decimal degrees
Northmost Latitude
36.532 N
Westmost Longitude
79.727 W
Navigate directly to the NED Download
Eastmost Longitude
79.020 W
Southmost Latitude
35.615 N
Point your browser to URL http://seamless.usgs.gov/
View and Order Datasets - United States Viewer.
Deselect NLCD format. Define Area by Coordinates.
Switch to Decimal Degrees. Clear Fields. Paste in the 4 coordinates above. Add Area.
Download and unzip the NED ArcGrid files.
Close

Figure A.26 DEM Extent Dialog – Alamance County

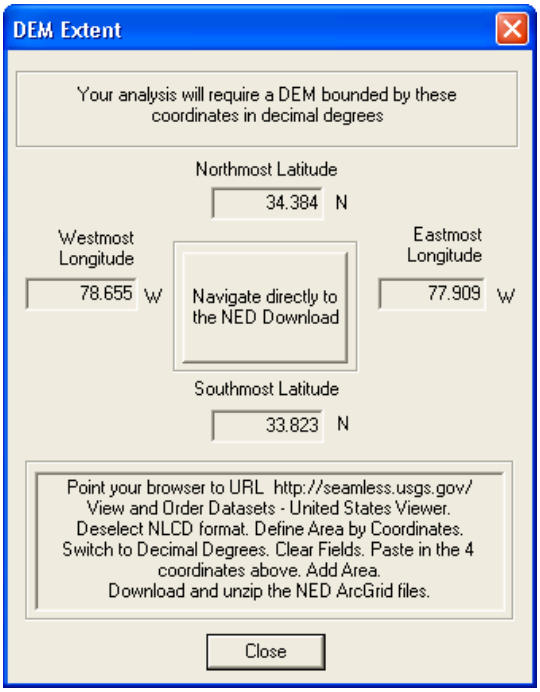

DEM Extent
Your analysis will require a DEM bounded by these coordinates in decimal degrees
Northmost Latitude
34.384 N
Westmost Longitude
78.655 W
Navigate directly to the NED Download
Eastmost Longitude
77.909 W
Southmost Latitude
33.823 N
Point your browser to URL http://seamless.usgs.gov/
View and Order Datasets - United States Viewer.
Deselect NLCD format. Define Area by Coordinates.
Switch to Decimal Degrees. Clear Fields. Paste in the 4 coordinates above. Add Area.
Download and unzip the NED ArcGrid files.
Close

Figure A.27 DEM Extent Dialog – Brunswick County

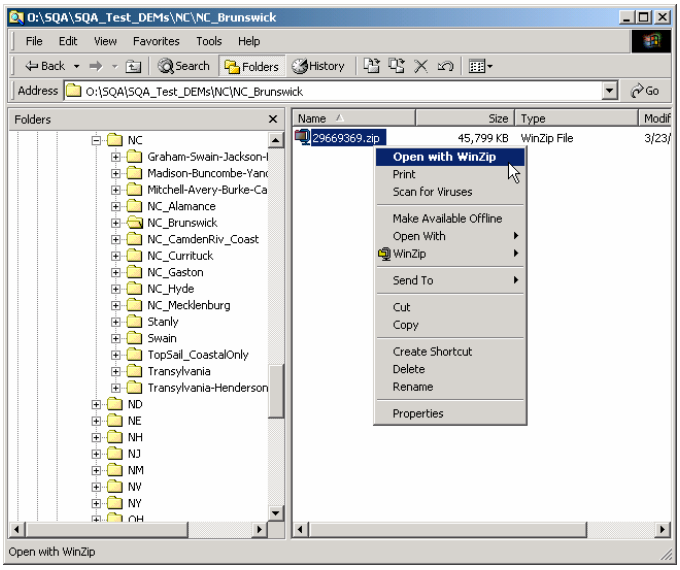
A.4.7 Download the DEM

Click on “Navigate directly to NED Download”. This will open up a web browser and take you to the USGS website. Click on “Download” link and wait for “File Download” prompt. Save the zip file somewhere on your hard disk. Once you have it, unzip it to some known place on your hard drive. One recommendation is to create a series of folders by State and county so that you can keep them and find them. The number the USGS gives you is a random number and you eventually could forget what is where.

Remember to unzip the DEM data once it has been downloaded. It is suggested that you might want to establish a standard location for all of your DEM data.

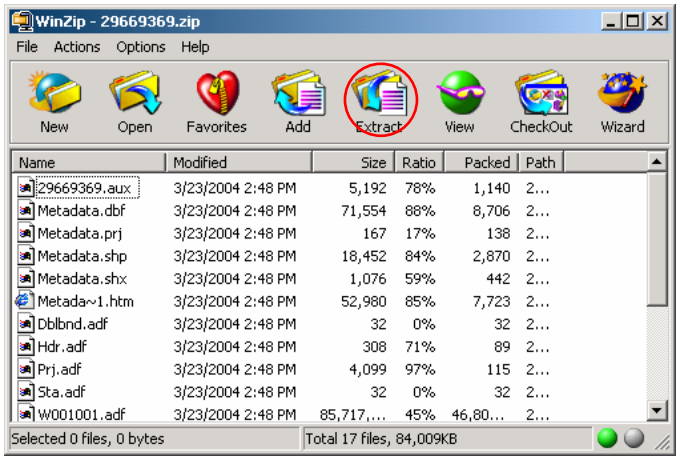
USERS WITH WINZIP

After downloading the DEM, right-click on the zip file and select “Open with WinZip.”



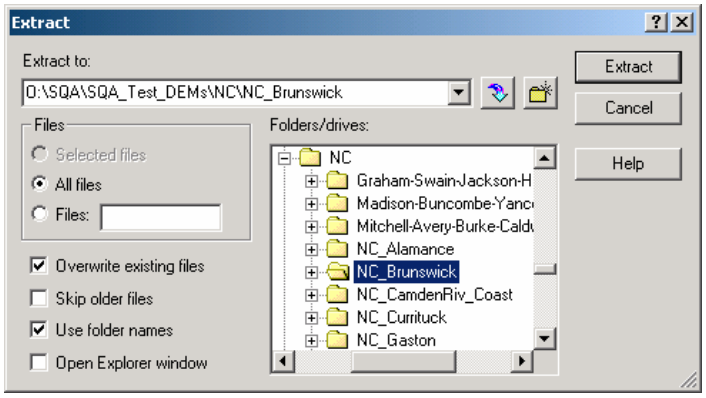
(Windows Explorer view of zip file)

From there, the WinZip utility opens and click on “Extract” (circled below).



(Winzip with zip file opened)

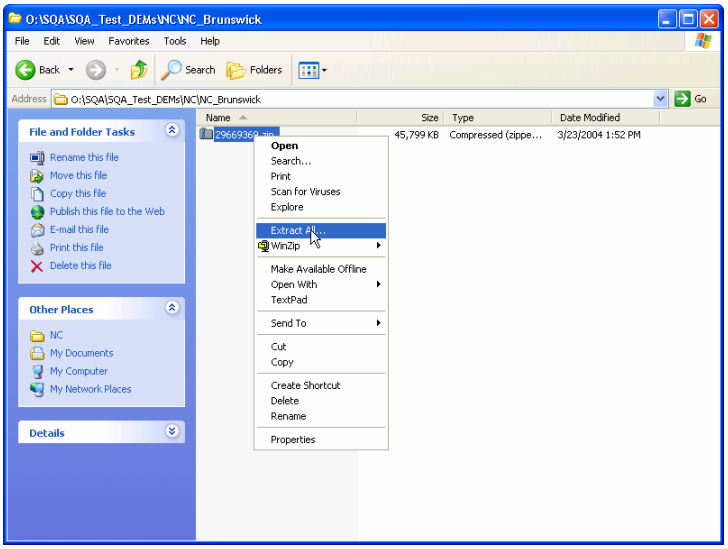
To select the location where the zip file will be extracted to, browse through the “Folders/drives” browser window. It would be best to select the same folder in which the zip file is contained. Once the location is selected, click on “Extract.”



(Selection of location for file extracted)

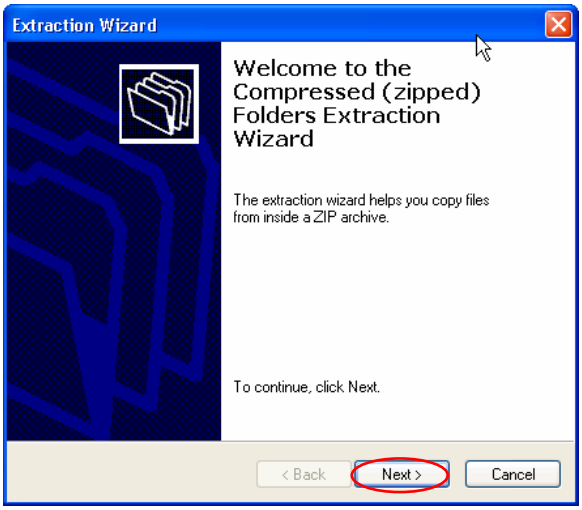
USERS WITHOUT WINZIP

After downloading the DEM, right-click on the compressed zip file and click on “Extract All.”



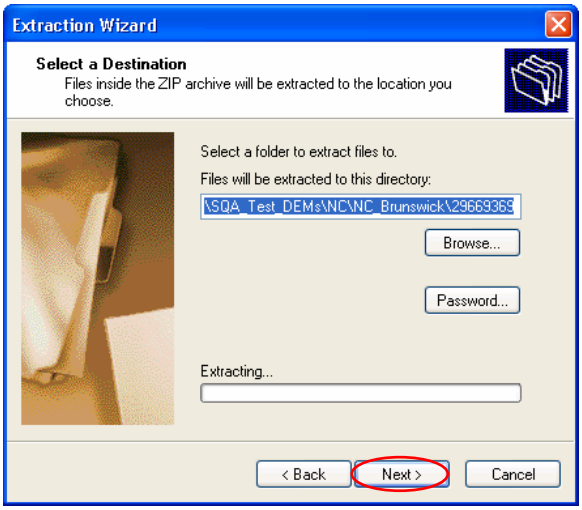
(Folder view of compressed (zipped) folder)

The “Extraction Wizard” utility will pop up. Click on “Next.”


Extraction Wizard
Welcome to the Compressed (zipped) Folders Extraction Wizard
The extraction wizard helps you copy files from inside a ZIP archive.
To continue, click Next.
< Back
Next >
Cancel

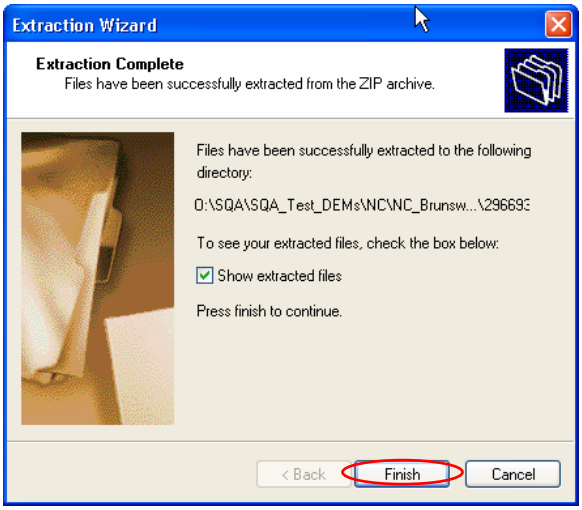
(Extraction Wizard)

The location of the extraction will be defaulted to the folder that contains the zip file. The location of the extracted file can be changed by clicking on the "Browse" button, however, it is highly suggested to use the default folder. Once the location is selected, click on "Next."



(Selection of location for file extracted)

Once the extraction is complete, the following dialog will appear. Click "Finish." The extracted files will show in a new window if it is selected as shown below. However, it is not necessary to see your extracted files.



(Confirmation of extracted file)

A.4.8 Select the DEM

Use the *Hazard\User Data* menu item and ensure this displays. Set Datum to NAVD88 and units to Meters. Click on Browse (open folder icon/button). Navigate to the place where you unzipped the USGS DEM file. When you select it, the DEM layer name and path will be added to the list box. Click on **OK**. At that time, the raw DEM will be merged (if necessary), clipped, and projected. This may take 5 – 10 minutes. When it is done, you should see the Region DEM layer and its hillshade loaded.

The Flood Model will merge DEM data automatically if more than one DEM file has been added to the dialog.

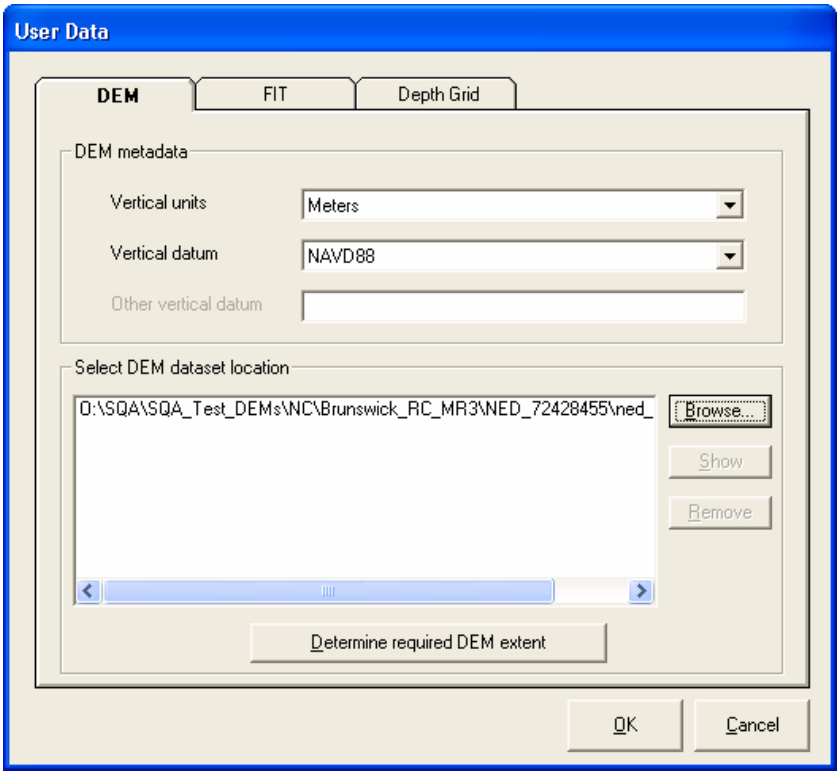


Figure A.28 Selecting the DEM Datasets

At this point, the processes for the hazards, riverine and coastal, diverge. Sections A.4.10 through A.4.13 cover the riverine hazard development for the installation verification. Sections A.4.14 through A.4.16 cover the coastal hazard development for the installation verification.

A.4.9 Stream Network Creation Check (Riverine Only)

Use the *Hazard\Develop Stream Network* menu item and ensure this display. The default is 10.0 miles, change to 2.0 miles. For now leave it at that. Click **OK**.

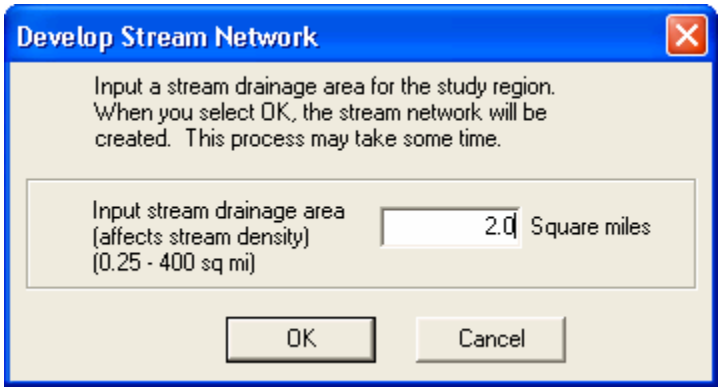

Develop Stream Network
Input a stream drainage area for the study region.
When you select OK, the stream network will be
created. This process may take some time.
Input stream drainage area
(affects stream density)
(0.25 - 400 sq mi)
2.0
Square miles
OK
Cancel

Figure A.29 Developing a Stream Network

At that time, the stream network will get created. This process may take from 15 to 30 minutes or more depending on the density of the river network selected (i.e., setting the drainage area to 1 mile will result in a denser stream network and will take more time). When it is done, you should see this:

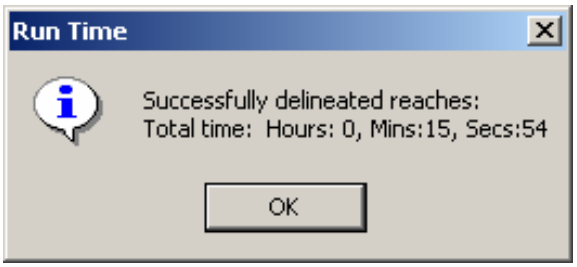


Figure A.30 Stream Network Completion Message Box

Underneath the message box, the river network will be drawn. Closing the message box, the user should see the following:

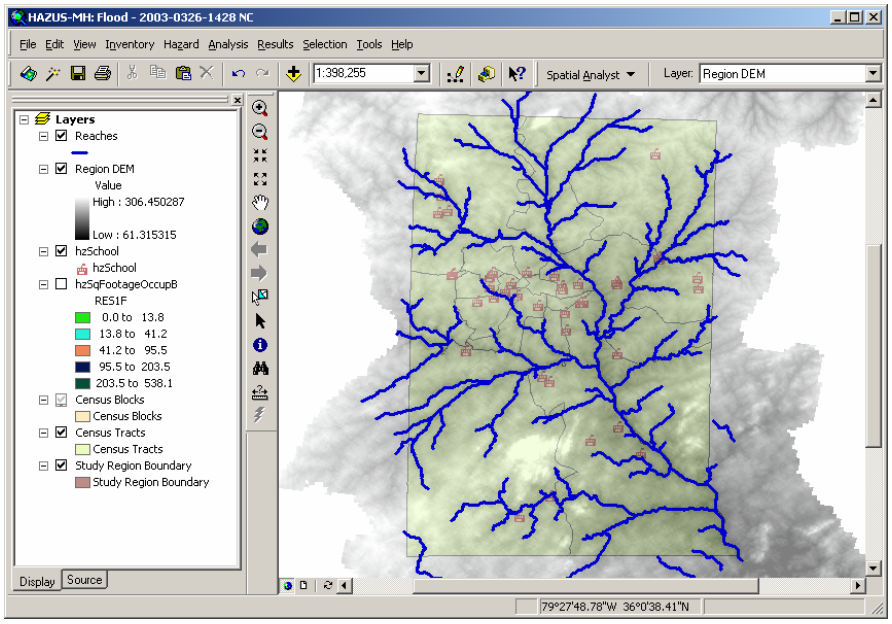


Figure A.31 The ArcMap Window Displaying the Completed Stream Network

A.4.10 Scenario Creation Check (Riverine Only)

Use the *Hazard\Scenario\New* menu item and ensure this display. Enter a name and a description that is meaningful to you. For this test we will select a few reaches. Click **OK**.

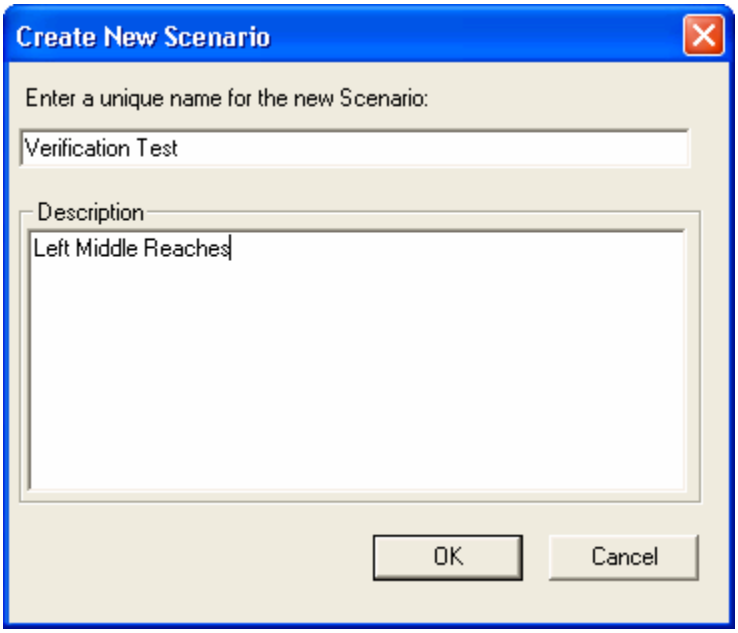


Figure A.32 Entering A Scenario Name (Riverine)

When the user has completed entering the Scenario name and selecting **OK**, the following dialog will display with the stream network visible in the map document.

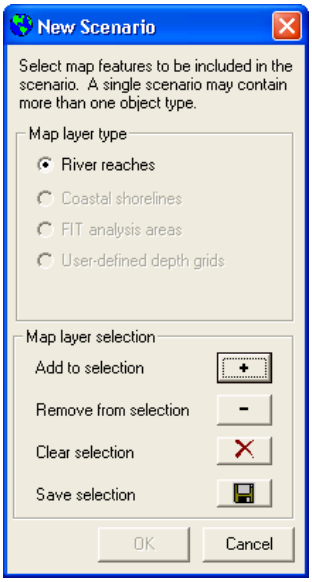


Figure A.33 New Scenario Selection Tools

Click on the **Select** symbol and select the reaches shown. Note they are close to a school so we can get results. Click on "**Save selection**". Then click **OK**.

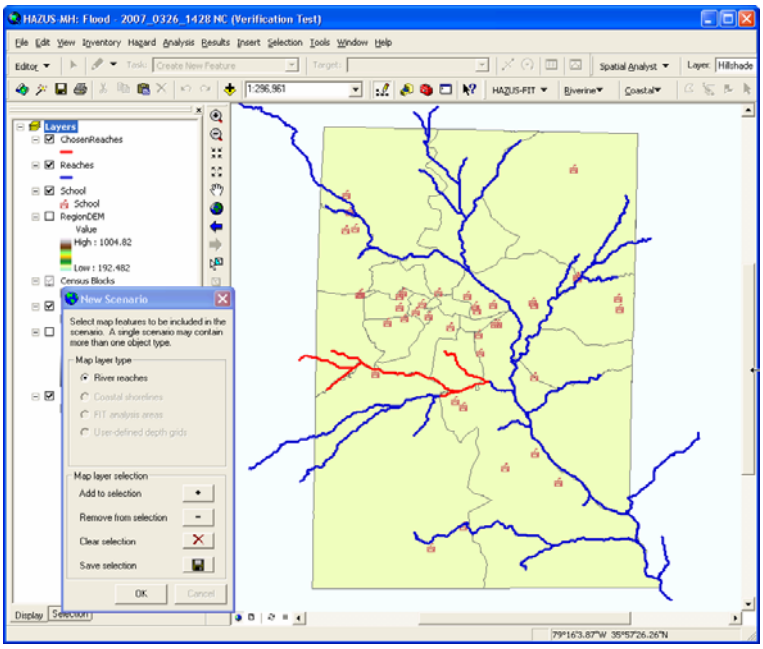


Figure A.34 Example of Selected Stream Reaches

The selected reaches will be displayed in light blue but they are displayed in red after they are saved.

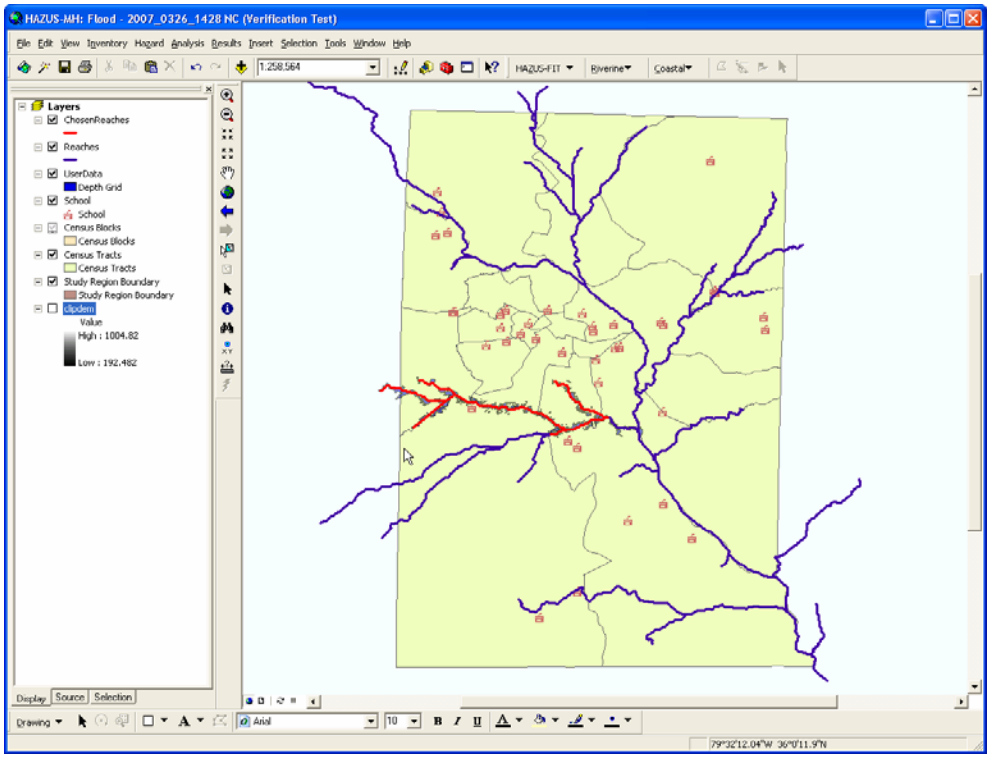


Figure A.35 Selected Stream Reaches Displayed After User Acceptance

A.4.11 Hydrology Check (Riverine Only)

Select the *Hazard\Riverine\Hydrology* menu item and hydrology calculations will begin. As it progresses, intermediate layers will be added to the map. The status bar globe will be spinning. This step may take 5 - 20 minutes. When it is done, you will see a dialog identifying successful completion and the processing time.

Note that the highlighted watersheds seen in the screen shot below will be automatically removed from your table of contents when the processing is completed.

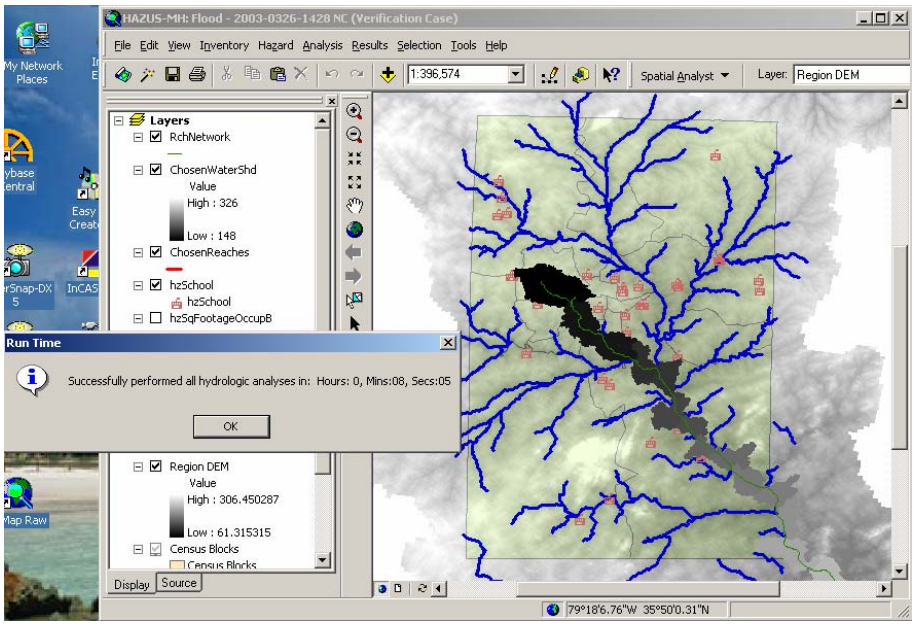


Figure A.36 SAMPLE Image, the Hydrology Analysis In Process

A.4.12 Delineate Floodplain – Riverine

Select the *Hazard\Riverine\Delineate Floodplain* menu item and ensure this dialog shows. Change the combo box to "Single Discharge". Change the top Discharge cell in the grid to 1,200 cfs (cubic feet per second). Click the Fill Down (circled) button to set all reaches (if more than one reach was selected) to 1,200 cfs discharge.

Click on **OK**. Hydraulics will begin. The status bar globe will be spinning. This step may take 5 - 15 minutes. When it is done, you should see this:

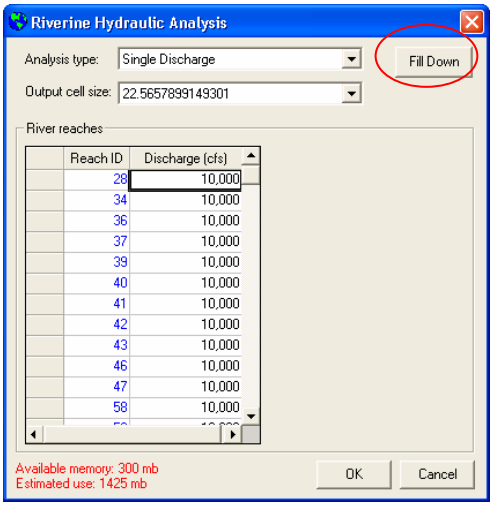


Figure A.37 Setting the Hydraulic Analysis Parameters

Once this completes in 5 –15 minutes, you should see two new layers as shown below:

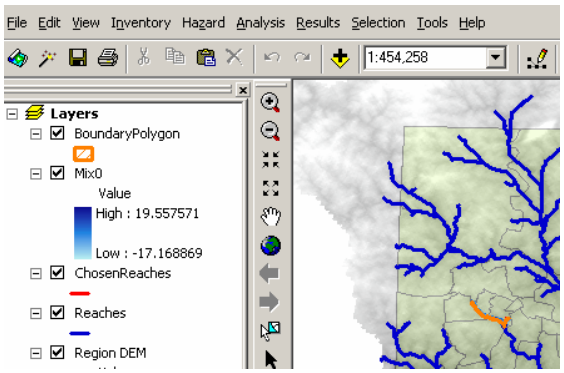


Figure A.38 Flood Depth Grid and Boundary Polygon in Table of Contents Following Successful Hydraulic Analysis

This completes the development of the riverine flood hazard.

A.4.13 Scenario Creation Check (Coastal Only)

Use the *Hazard\Scenario\New* menu item and ensure this displays. Enter a name and a description that is meaningful to you. As Brunswick County has a single shoreline (i.e. no islands or complex bays) you will select the visible shoreline. Click **OK**.

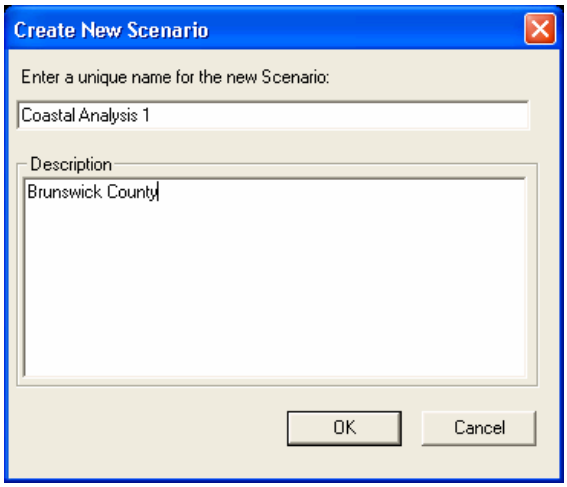


Figure A.39 Entering A Scenario Name (Coastal)

When the user has completed entering the Scenario name and selecting **OK**, the following dialog will display with the shorelines visible in the map document.

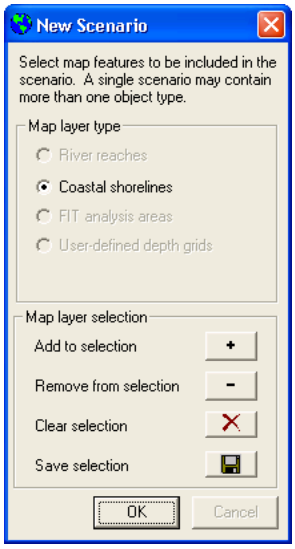


Figure A.40 New Scenario Selection Tools (Coastal)

Click on the **Select** symbol and select the shoreline shown. Click on "**Save selection**". Then click **OK**.

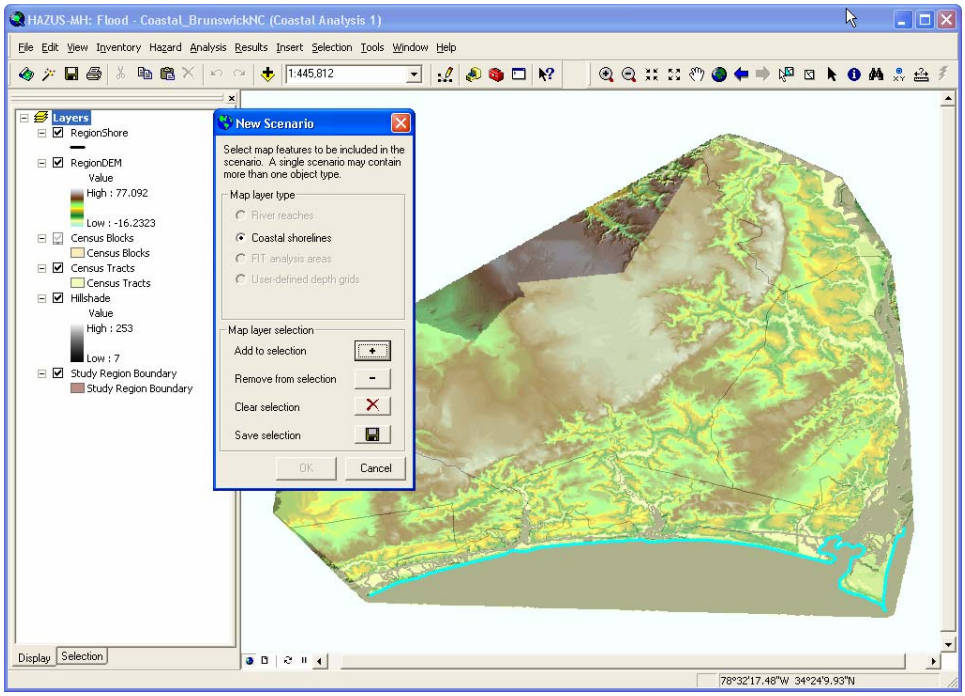


Figure A.41 Example of Selected Shoreline

The selected shoreline will be displayed in light blue, but it will be displayed in green after it is saved.

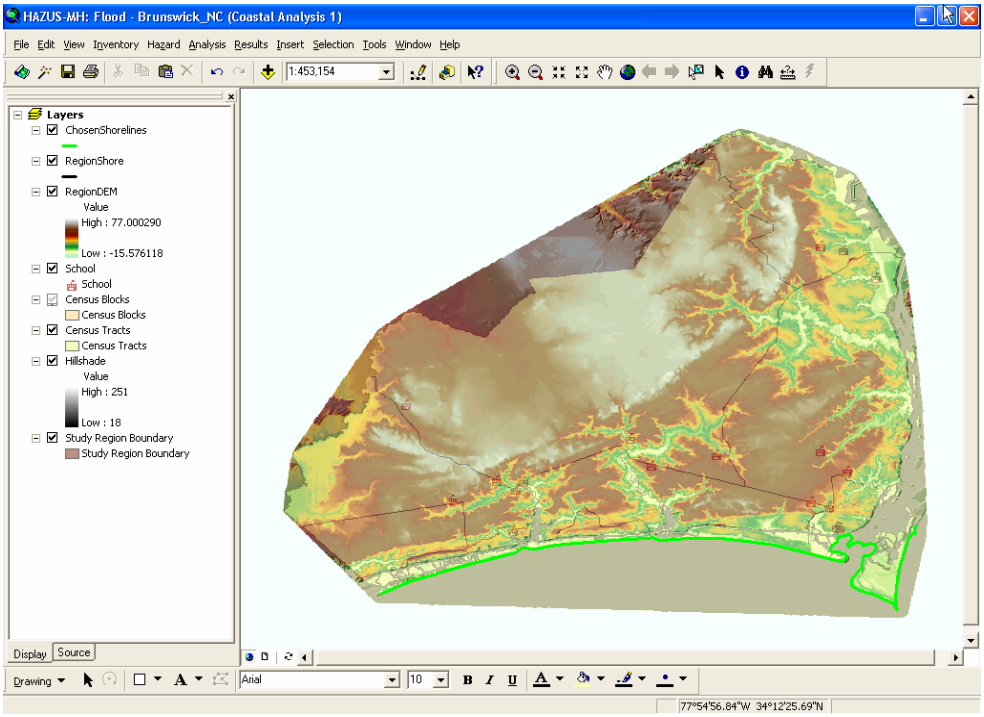


Figure A.42 Selected Shoreline Displayed After User Acceptance

A.4.14 Shoreline Characterization (Coastal Only)

After the scenario is defined and shoreline(s) are selected, the Shoreline Characterization automatically starts a series of interactive steps required to define the shoreline thereby allowing the flood model to perform the proper hazard analysis to develop the flood depth grids. The first step is to identify the starting and ending points of your analysis. In this case we will shift the start and end points in from the defaults shown on the map. The shoreline characterization dialog should appear as follows.

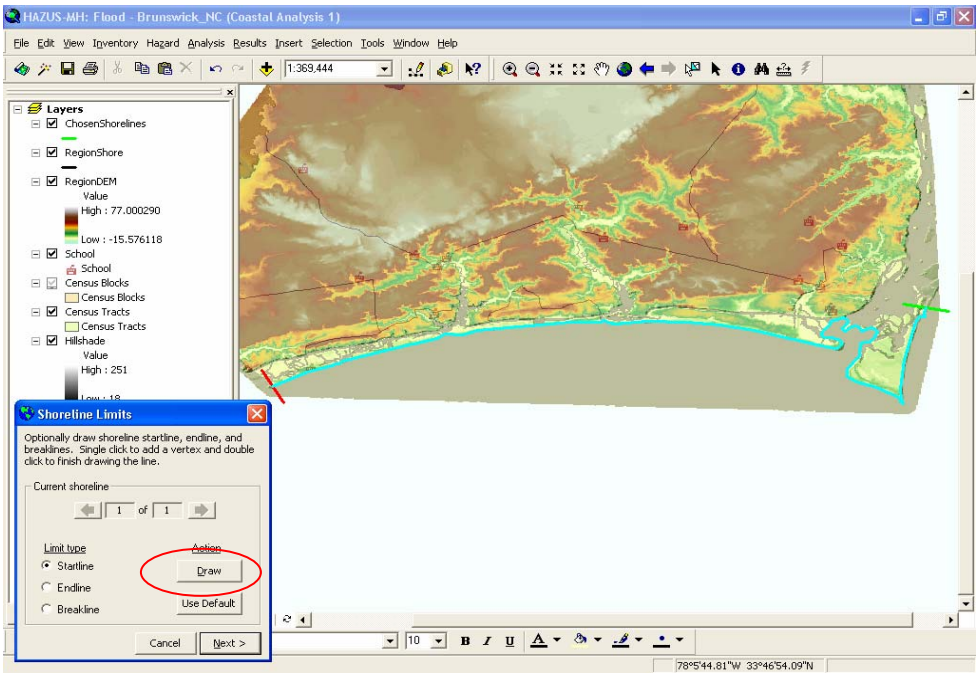


Figure A.43 Selected Shoreline Displayed After User Acceptance

The shoreline limits dialog allows the user to modify the limits of the analysis from the default start and end to one of their own selection. In this case, we will shift the shoreline start and end to reduce the overall area being analyzed. Ensure that the radio button **Startline** is selected and click on the **Draw** button (circled). The cursor will change into a draw tool (looks like a crosshair) and you can start the line inland approximately where the line (circled) is shown in Figure A.44 and complete the line in the ocean by double clicking. There is no need to hold the mouse buttons while drawing. You should see the image in Figure A.44.

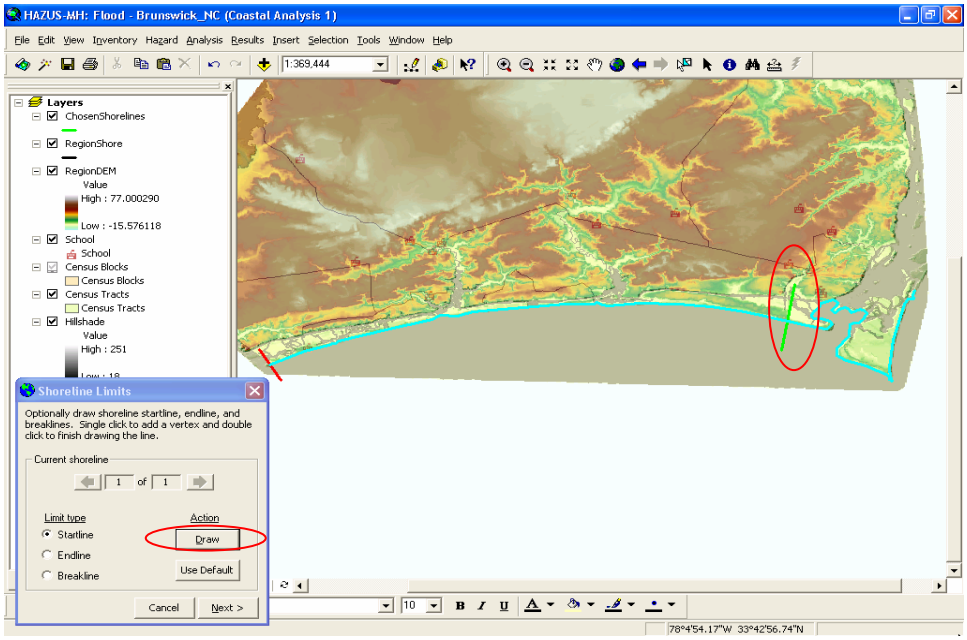


Figure A.44 Revised Shoreline Start

Ensure that the radio button **Endline** is selected and click on the **Draw** button (circled). Follow the same process of starting the line inland of the shoreline and extending the line into the ocean (circled) completing the process by double clicking on the mouse. The results should be similar to that seen in Figure A.45 below.

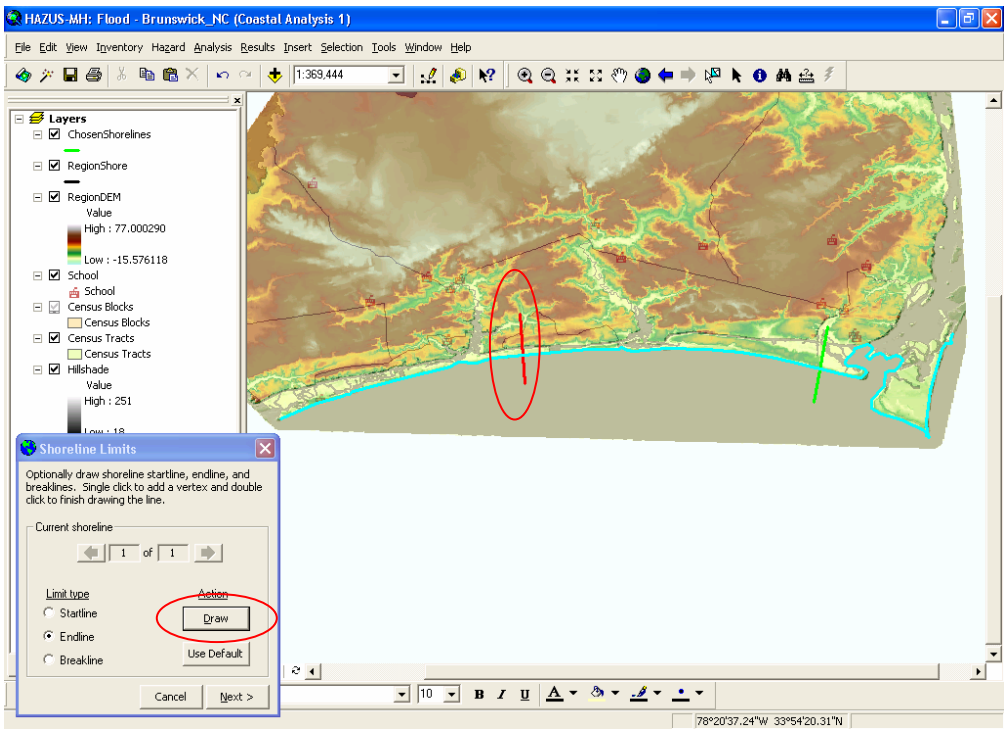


Figure A.45 Revised Shoreline End

To add another shore segment, ensure that the radio button **Breakline** is selected and click on the **Draw** button. Follow the same process of starting the line inland of the shoreline and extending the line into the ocean (circled), completing the process by double clicking on the mouse. The results should be similar to that shown in Figure A.46 below.

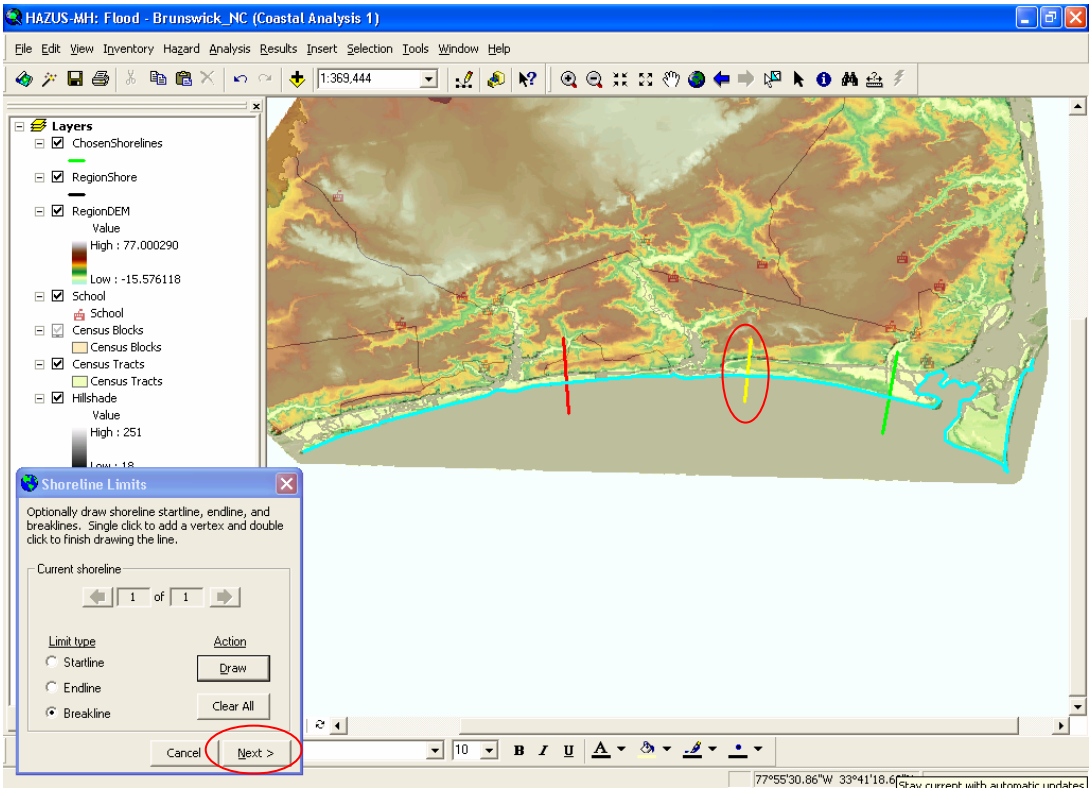


Figure A.46 Added Shoreline Segment (Breakline)

Selecting **<Next>** on the Shoreline Limits dialog (circled above) opens the next step in the process where the user is required to provide some basic shoreline characterization that defines the internal models that will be run during the hazard development process.

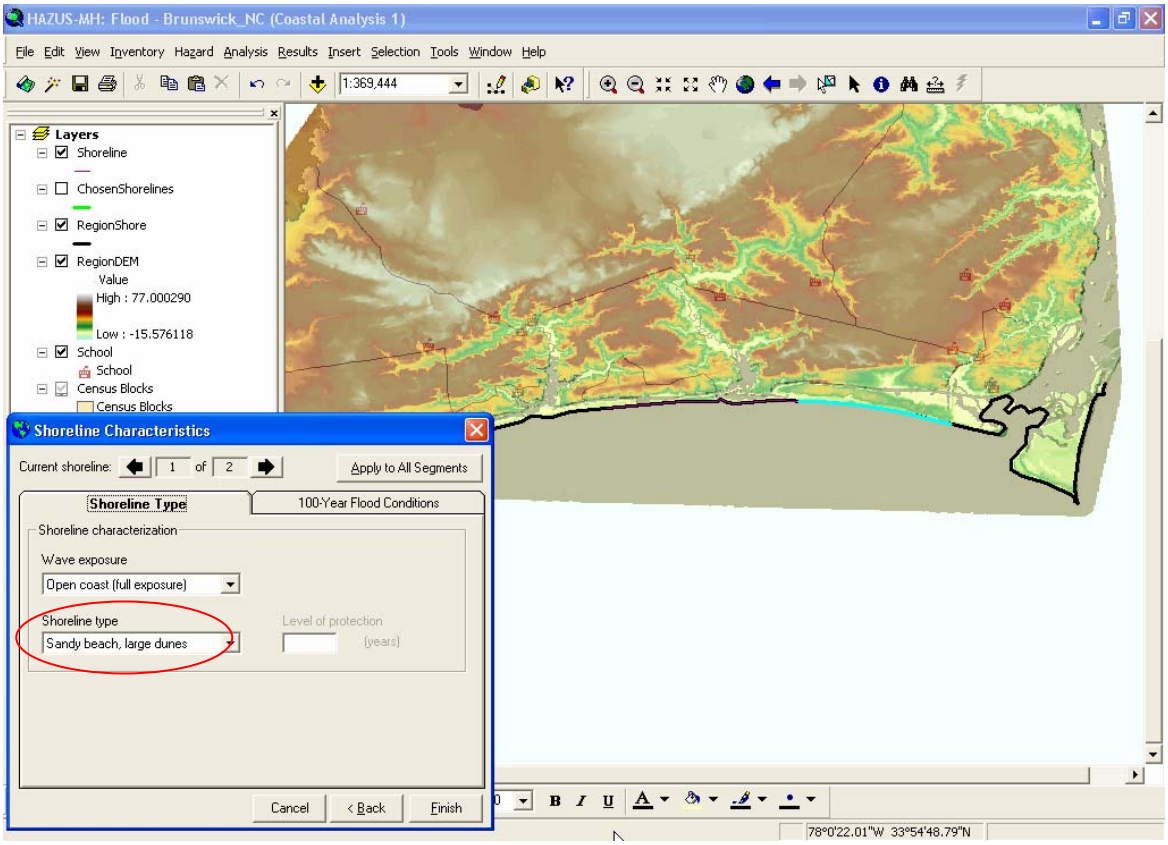


Figure A.47 Shoreline Segment Characterization

The shoreline characterization dialog has two tabs and a series of user inputs. For this exercise, select "Open coast (full exposure)", then select "Sandy Beach, large dunes" in the dropdown combo box (circled) on the Shoreline Type Tab. Then select the 100-year Flood Conditions tab to input the 100-year still water elevation (see Figure A.48).

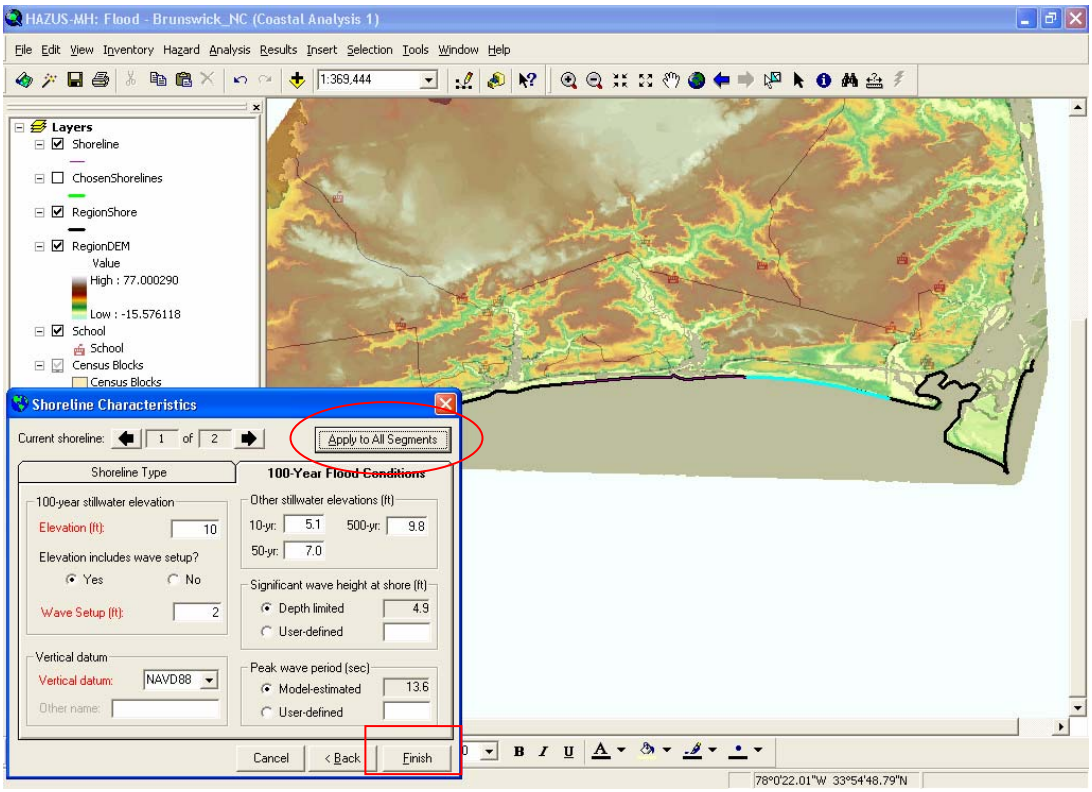


Figure A.48 Shoreline Segment Characterization 100-Year Flood Conditions Tab

For this example, please enter a 100-year Stillwater elevation of 10ft (Note: this is an approximate number picked for simplicity, normally user should check FIS), click “Yes” to Elevation includes wave setup, set the wave setup to 2ft (arbitrary number for the sake of this example) and remember to set the Vertical datum to NAVD88 to match the DEM input earlier. Normally, the user may perform this process for each shoreline segment, 2 segments in this case. For validation purposes, please use the **Apply to All Segments** Button (circled). And click on the **Finish** button (rectangle). This completes the shoreline characterization.

A.4.15 Delineate Floodplain - Coastal

From the menu *Hazard\Coastal\Delineate Floodplain*, the dialog seen in Figure A.49 should appear. In this dialog, select the Single Return Period option in the combo box and enter 500 in the editable field for shoreline segment 1. The second shoreline segment will automatically be filled since shorelines cannot have different return intervals.

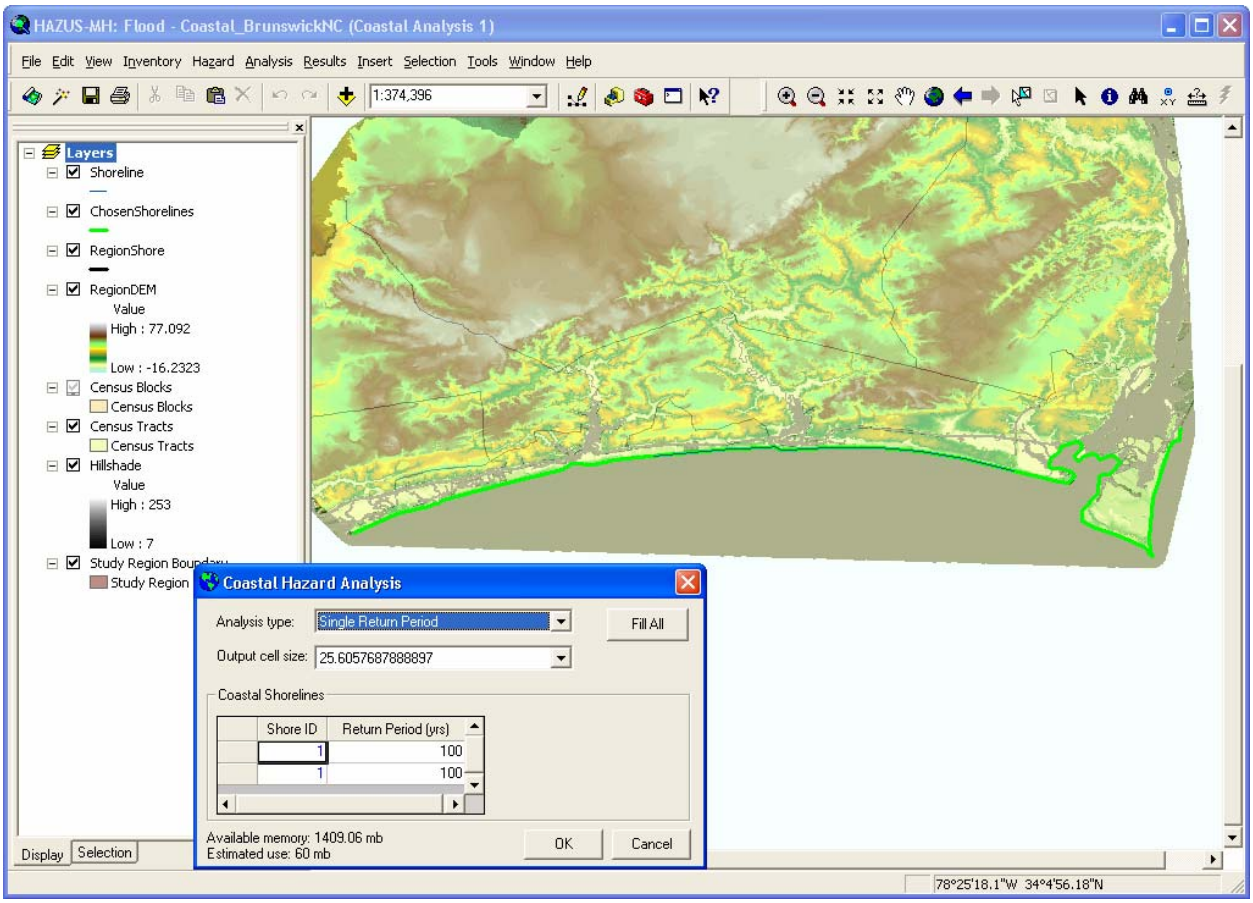


Figure A.49 Compute Flood Hazard – Coastal Hazard

Once you have set the return period, click on **OK** to start the coastal hazard processing. This process may take about an hour.

Upon completion, the coastal flood hazard depth grid and the floodplain polygon should be added to the table of contents and appears as seen in Figure A.50.

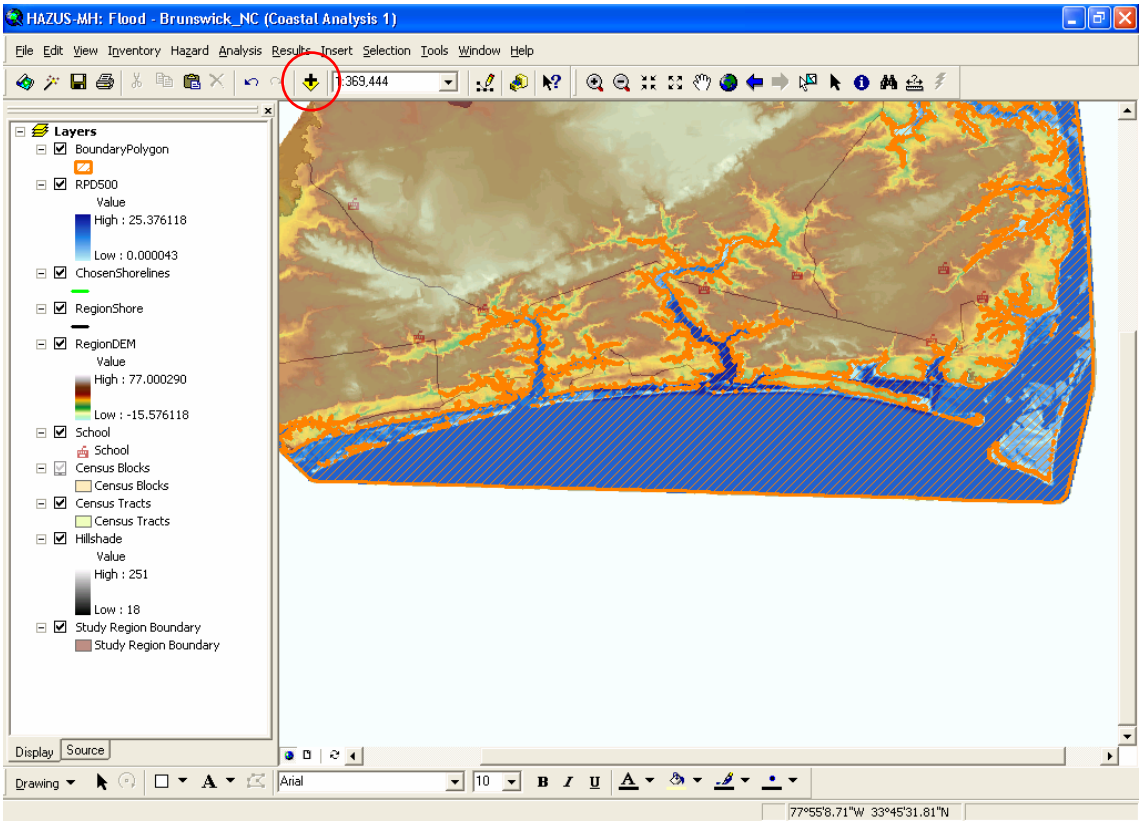


Figure A.50 The Completed Coastal Flood Hazard

Note: If the user removes the depth grid and/or floodplain polygon layers, the user can add them back manually.

Click on the **Add Data** button (circled above). Navigate to the scenario folder. Browse through the Coastal folder, double-click on CaseOutput.mdb, double-click on Coastal, click on BoundaryRP500, and click on the **Add** button (circled in A.52). The following images will walk the user through the process.

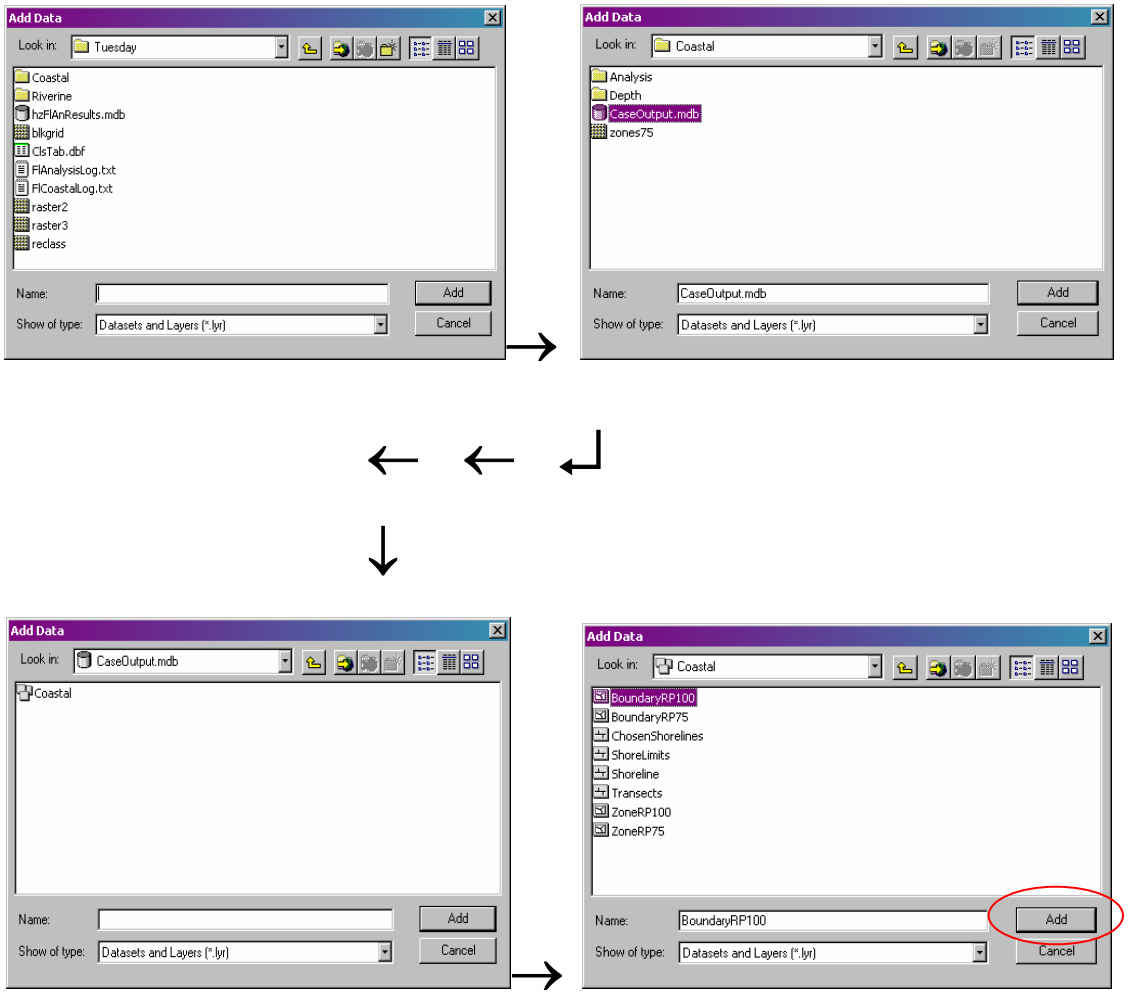


Figure A.51 Browsing for the Floodplain Boundary within the Scenario Folder

Add the floodplain boundary to the table of contents by clicking on **Add** button in the dialog (circled in Figure A.50). In the scenario folder, double-click on the Coastal folder, double-click on the Depth folder, click on rpd500, and click on the **Add** button (circled below). The flood depth grid can be found within Depth folder seen below:

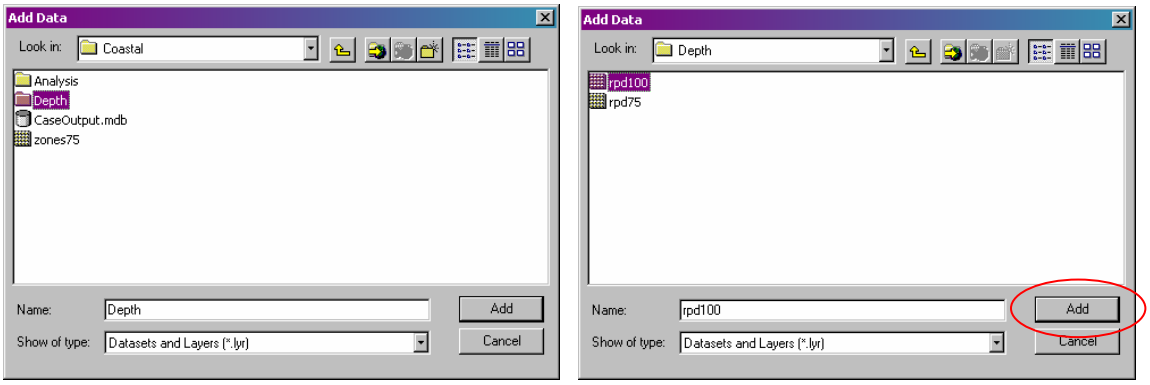


Figure A.52 Browsing for the Flood Depth Grid within the Scenario Folder

The flood depth grid is labeled by the return period of our analysis (rpd500). Adding these layers will be performed automatically in the final release of the flood model.

This completes the development of the Coastal Flood Hazard.

A.4.16 Analysis Verification

These steps will demonstrate that a flood scenario that has a calculated hazard can have an analysis run against it.

A.4.17 Damage Function Check

Select the *Analysis\Damage Functions\Buildings* menu item and ensure this dialog shows. To view the Coastal damage functions, change the Hazard Type to Coastal A-zone or Coastal V-zone. In both cases, the functionality described below is consistent between the dialogs.

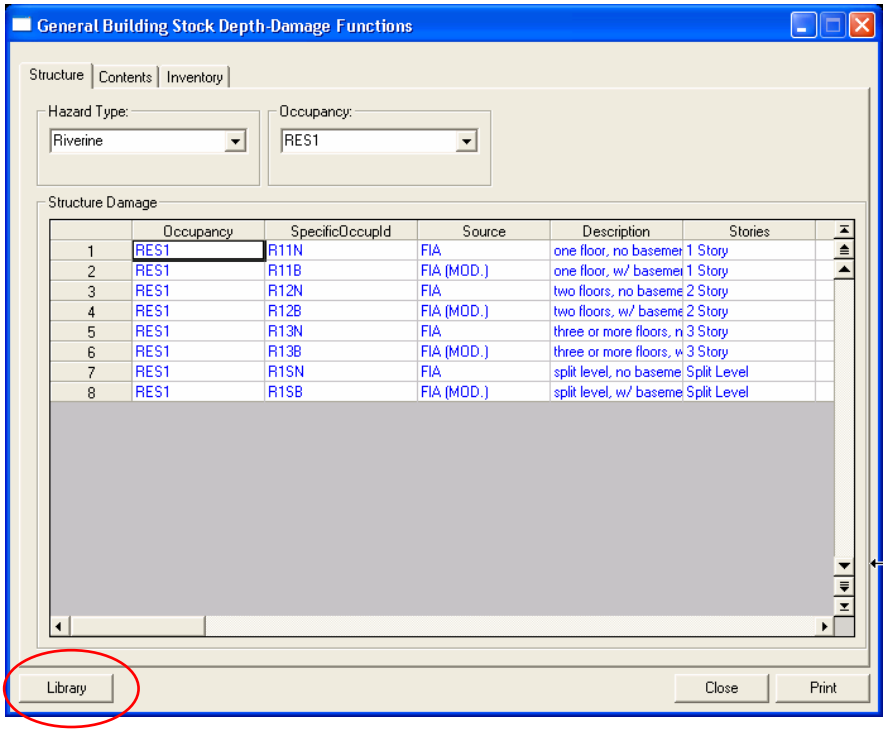

General Building Stock Depth-Damage Functions
Structure
Contents
Inventory
Hazard Type:
Riverine
Occupancy:
RES1
Structure Damage
Occupancy
SpecificOccupId
Source
Description
Stories
1 RES1 R11N FIA one floor, no basemer 1 Story
2 RES1 R11B FIA (MOD.) one floor, w/ basemer 1 Story
3 RES1 R12N FIA two floors, no baseme 2 Story
4 RES1 R12B FIA (MOD.) two floors, w/ baseme 2 Story
5 RES1 R13N FIA three or more floors, n 3 Story
6 RES1 R13B FIA (MOD.) three or more floors, w 3 Story
7 RES1 R1SN FIA split level, no baseme Split Level
8 RES1 R1SB FIA (MOD.) split level, w/ baseme Split Level
Library
Close
Print

Figure A.53 General Building Stock Depth Damage Function Dialog

A.4.18 Damage Library Check

Click the **Library** button (circled) and ensure this dialog shows. Close the dialog when finished. Click **Close** to close the Damage dialog too.

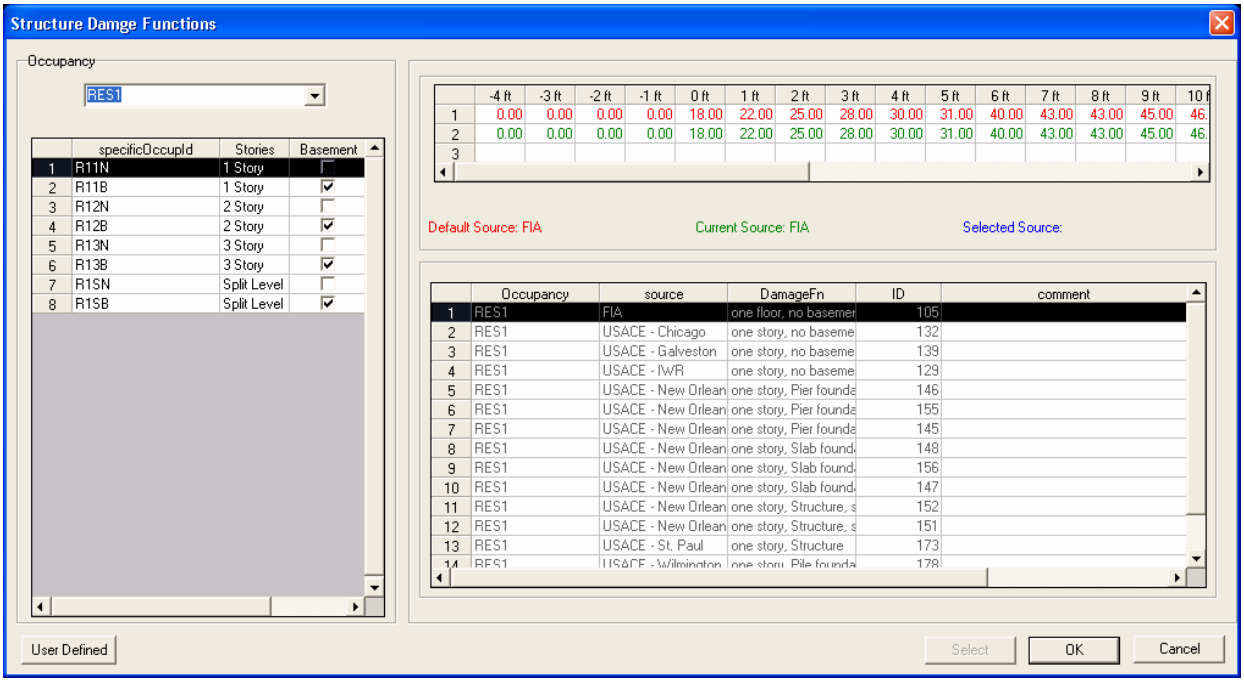


Figure A.54 General Building Stock Depth Damage Function Library

A.4.19 Run Analysis

Select the *Analysis\Run* menu item and ensure this dialog shows. Check both the General Building Stock and Essential facilities to expand the tree and select the following analyses as shown in Figure A.55.

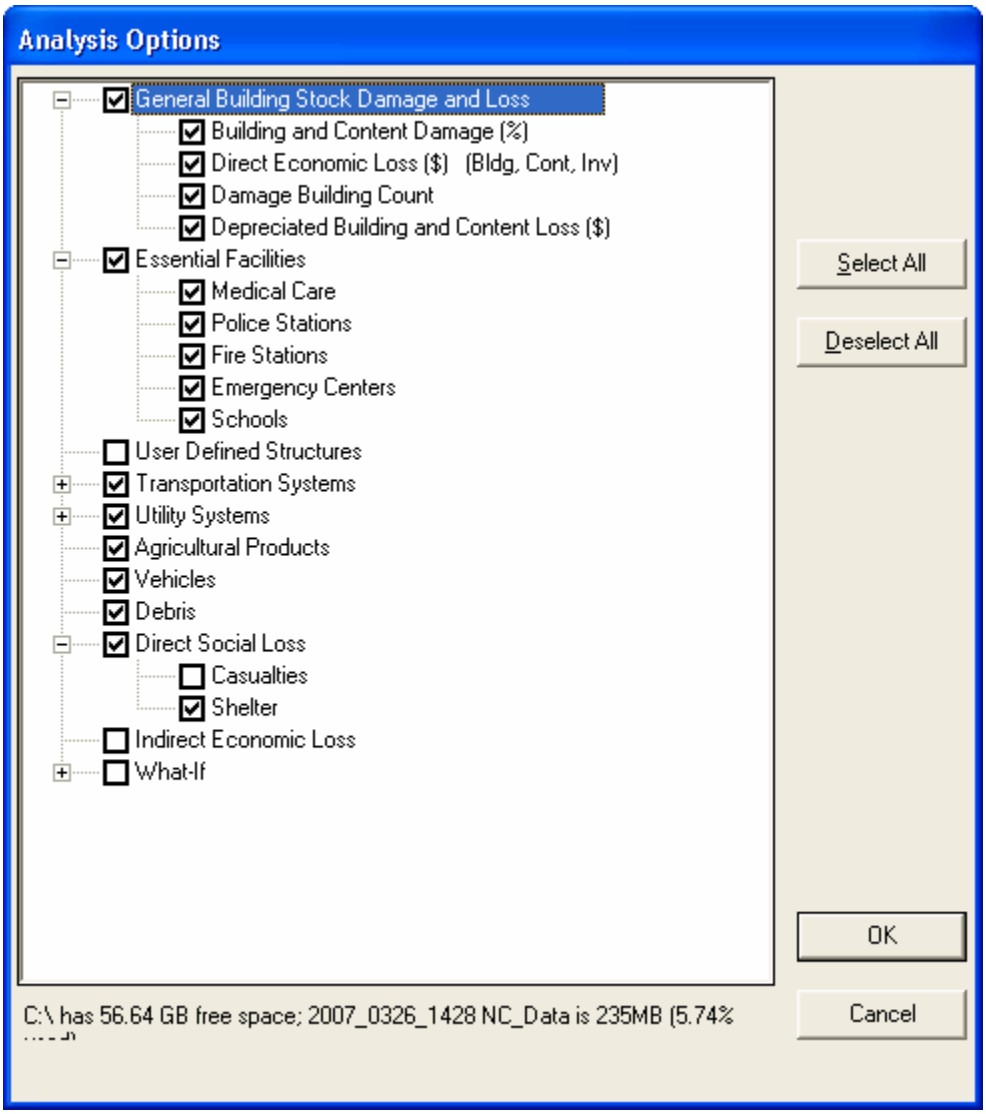


Figure A.55 Analysis Options Dialog with Validation Selections

Click **OK** and the analysis should commence.

A.4.20 Results Verification

These steps will demonstrate that a flood scenario that has been analyzed can show both browser based results and Crystal Summary reports.

A.4.21 Select the Results to View

Select the **Results\View Current Scenario Results By** menu item and ensure this dialog shows.

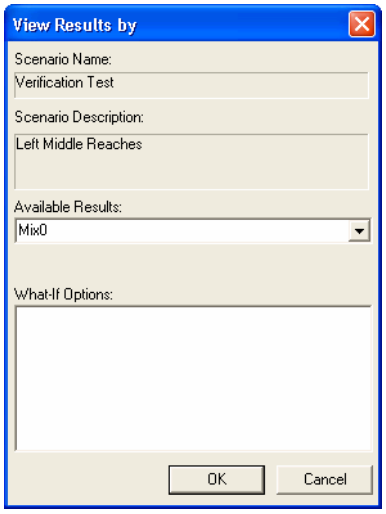


Figure A.56 View Results by dialog (Riverine)

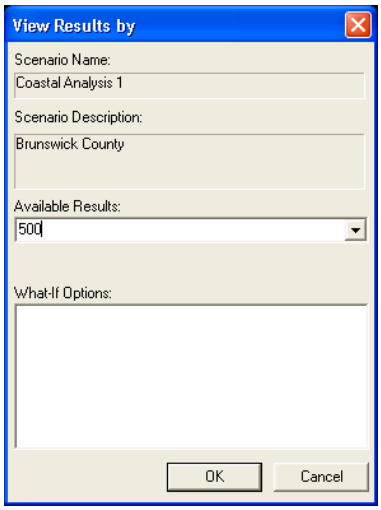


Figure A.57 View Results by Dialog (Coastal)

Use the combo box to select the return period of interest. We will assume you accept the default in the remaining screen shots. Click **OK** to close the dialog.

A.4.22 Show the Results for Schools

Select the *Results\Essential Facilities* menu item and ensure this dialog shows. Note that in many cases, essential facilities do not fall within the floodplain. If the dialog appears to have no data (as shown below) the user may want to return to the *Inventory menu\Essential Facilities* submenu and press the map button to view the locations of the essential facilities of concern. Click **Close** to close the dialog.

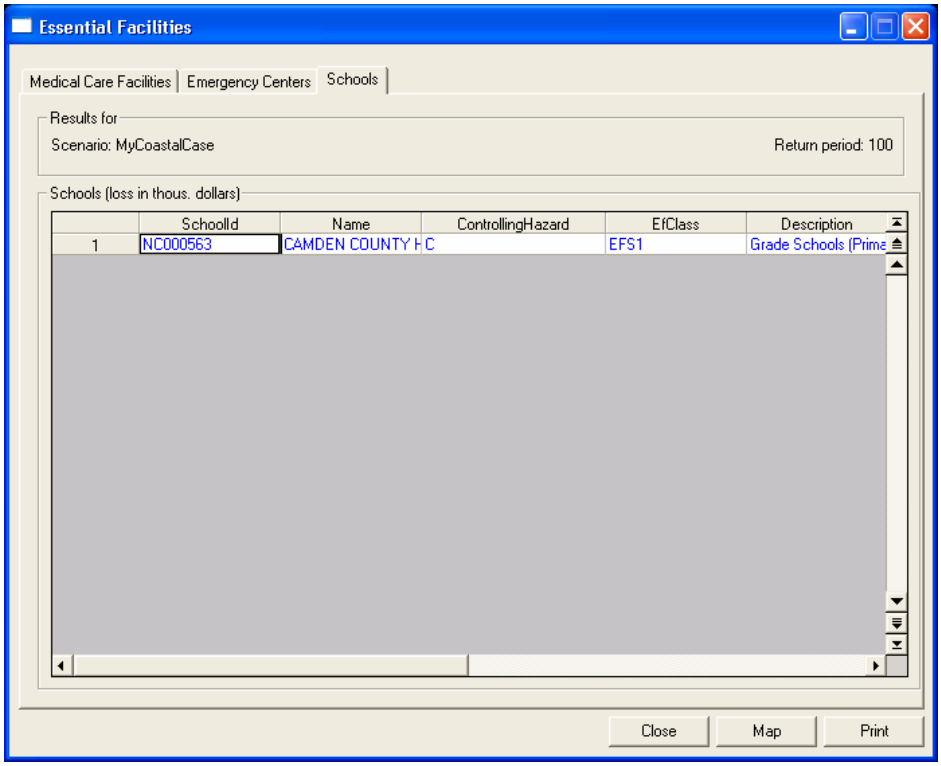


Figure A.58 Essential Facilities Results Dialog

A.4.23 Show the Summary Reports

Select the *Results\Summary Reports* menu item and ensure this dialog shows.

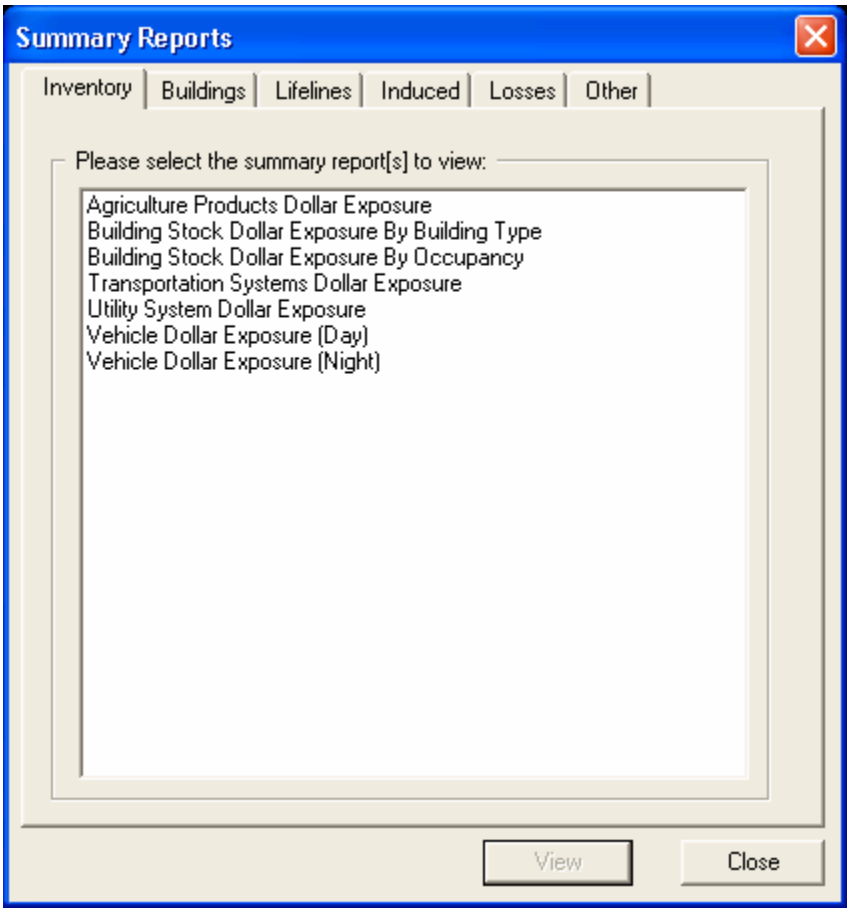


Figure A.59 Summary Reports Dialog

Click on the Building tab and select the top and bottom rows as below:

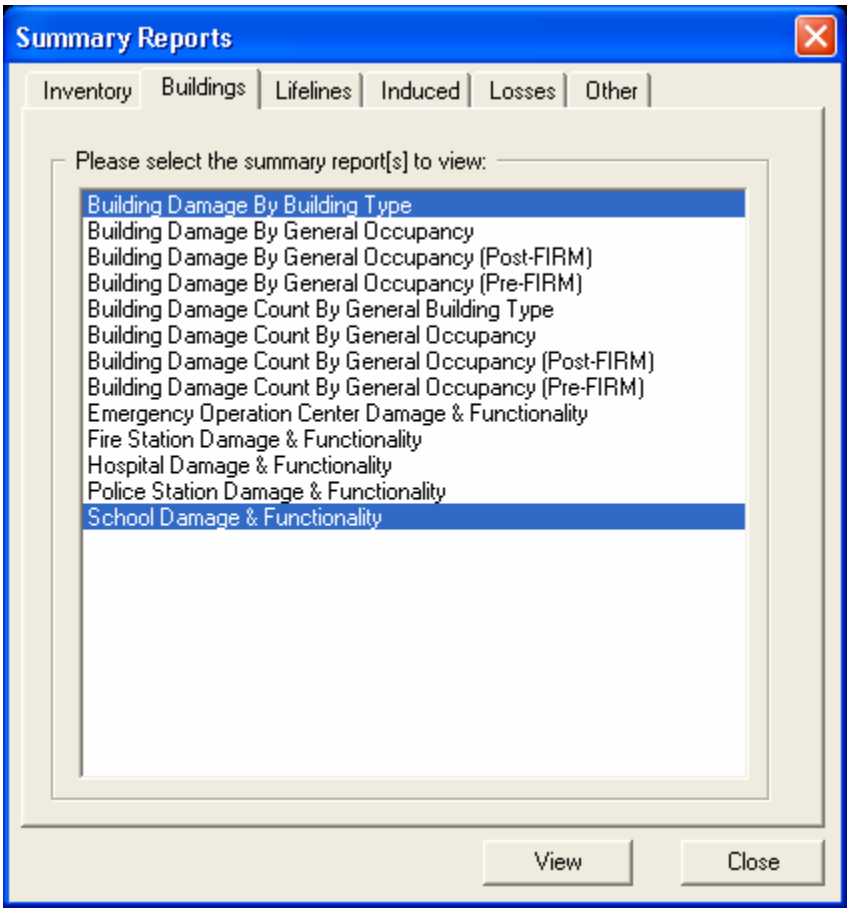


Figure A.60 Summary Reports Dialog, Buildings Tab

Click **View** and the following Crystal reports should appear.

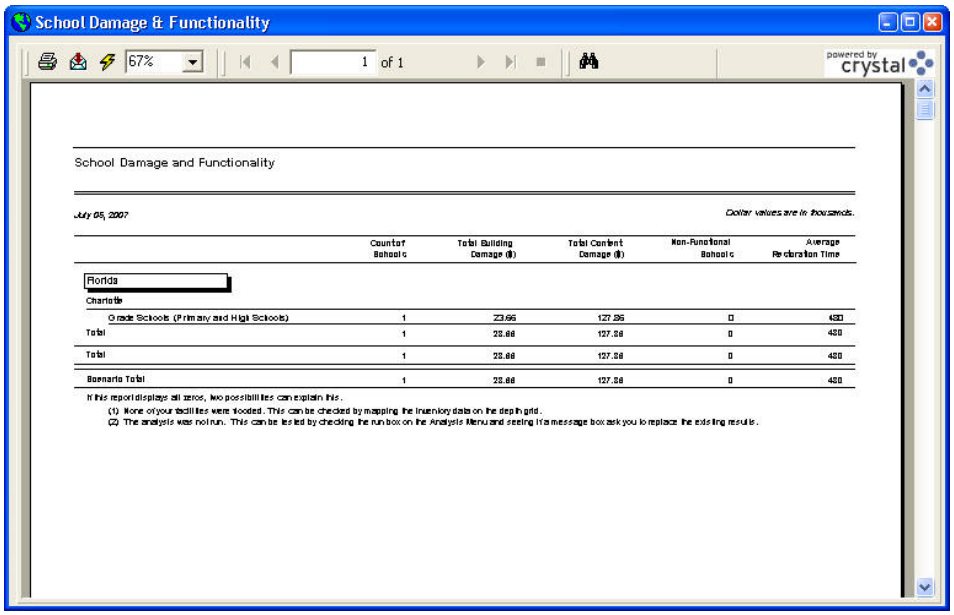

School Damage & Functionality
67%
1 of 1
powered by crystal
School Damage and Functionality
July 05, 2007
Dollar values are in thousands.
Count of Schools
Total Building Damage ($)
Total Content Damage ($)
Non-Functional Schools
Average Restoration Time
Florida
Charlotte
Grade Schools (Primary and High Schools)
Total
Total
Buenaria Total
If this report displays all zeros, two possibilities can explain this.
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Figure A.61 Sample School Damage and Functionality Summary Report

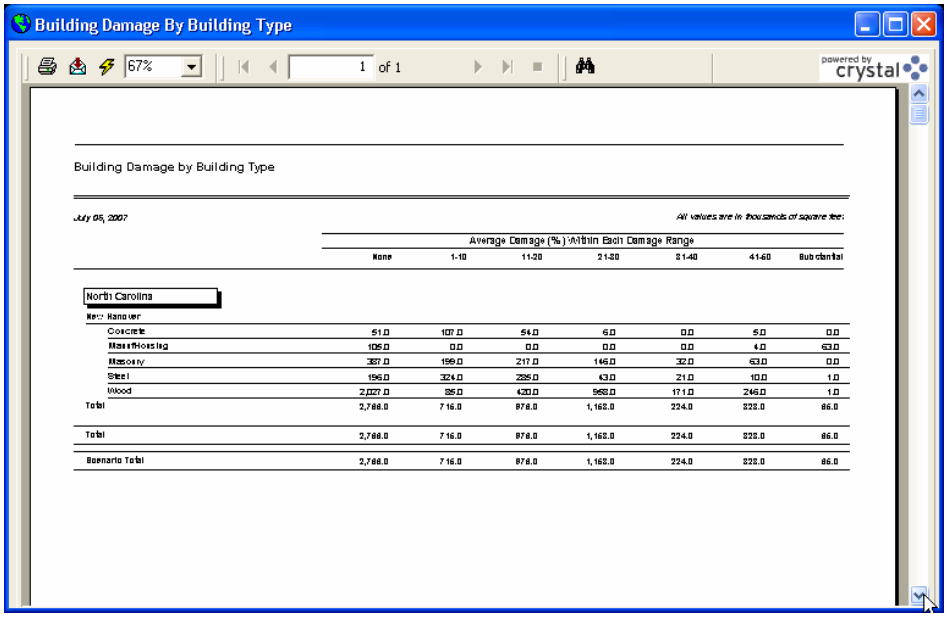


Figure A.62 Sample Building Damage by Building Type Summary Report

A.4.24 Final Verification

This concludes the installation verification process. Close all dialogs and print windows that may be open and close ArcMap. You should get a final message similar to this:

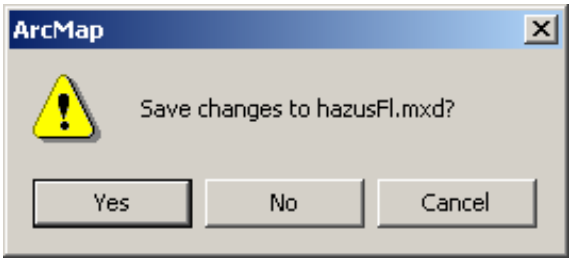


Figure A.63 Save HAZUS Flood MXD Document

This allows the user to save the settings (table of contents, etc) currently active in the map document. The user can chose to save these or rely on the model to reopen the layers when opening a scenario when needed. In this case, select **No**. Your ArcMap session will conclude and you can then re-open **HAZUS** and develop your own study regions.

A.5 Limitations Of Use For The HAZUS Flood Model

The user can expect the following limitations in using the Flood Model:

1. SQL Server 2005 Express Edition has a size limit of 4 GB per database, which affects the size of the region you can analyze. The data for the 3 hazards share the 4 GB limit. To work-around the 4 GB database limit, the full version of Microsoft SQL Server must be used. Refer to Appendix H of Users Manual for details.
2. Many functions take a long time to run. The speed of study region aggregation can be increase by copying the database to the local hard disk. The process is described in Section A.6 of the User Manual.
3. Components of independently developed data sets might not line up on maps, for example, the placement of bridges and roads, and facilities.
4. Inventory data and subsequently the Level 1 analysis functionality is unavailable for the US held territories.
5. The flood model is unable to run hydrology for the State of Alaska and Hawaii. Users in those states are required to run single discharges for analysis.
6. When running the hydraulic (Delineate Floodplain) analysis the recommended limitation is 24-reaches for the suite and 90-reaches for single discharge or single return period, assuming the machine has 2 GB of RAM.
7. The BIT module only provides square footage, dollar exposure, and building count data to the Flood Model.
8. Due to lack of default data, riverine users in the States of Hawaii and Alaska will be unable to perform hydrologic analyses. These users may still delineate the floodplain; however, options of specific return period and suite of return periods will be unavailable. Instead specific discharge should be selected.
9. The coastal What Ifs, Long-term Erosion and Shore Protection, are disabled.

A.5.1 Freeing Memory Using SQL Server Manager

SQL Server can often lock memory as a working set. Because memory is locked, **HAZUS** or other applications might receive out of memory errors or run slower. To work around this problem, restart the SQL Server service as follows:

1. Restart your computer by clicking **Start,** and then click **Shut Down.** In the "**What do you want the computer to do?"** list, click **Restart.** NOTE: Restarting will close all open applications, so be sure to save your work before choosing to re-start.

2. Restart SQL Server using the SQL Service Manager. Use the following process to open SQL Server Service Manager (SQL SSM) and restart the service:

a. Close **HAZUS** and related applications (BIT and InCAST), if they are running.

b. Open a Command window (Start | Run | Cmd)

c. Type NET STOP MSSQL$HAZUSPLUSSRVR and hit Enter. You should see a message about the service stopped successfully.

d. Type NET START MSSQL$HAZUSPLUSSRVR and hit Enter. You should see a message about the service started successfully.

e. Close the Command window by typing Exit.

A.5.2 Increasing Virtual Memory to Run Large Study Regions

An "out of memory" error might occur when running a flood analysis for a large study region. This occurs if the current page file size is not enough to carry out updates to the SQL Server database. To work around this problem increase the page file size. The process (in Windows 2000. See page xi for instructions in Windows XP) is as follows:

1. Open the control panel folder and locate the system icon. To open the control panel, click on **Start**, point to **Settings**, and then click **Control Panel**.

2. Double-click the system icon to open the **System Properties** dialog (shown in Figure A.64).

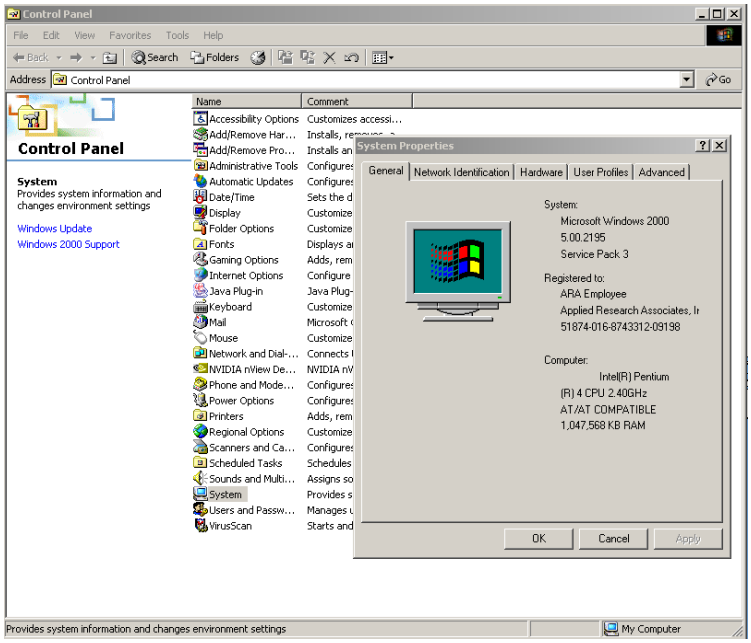


Figure A.64 Control Panel Folder and the System Properties Dialog

3. On the **Advanced** tab, click **Performance Options**, and under **Virtual memory**, click **Change**. (Figure A.65 through Figure A.66)

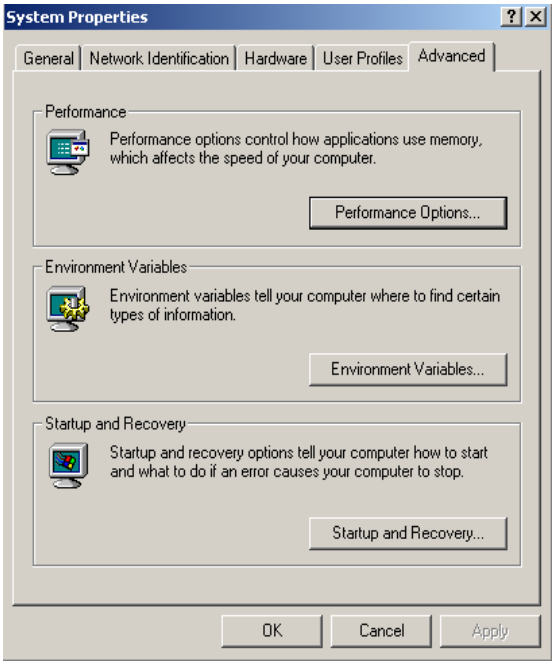

System Properties
General
Network Identification
Hardware
User Profiles
Advanced
Performance
Performance options control how applications use memory, which affects the speed of your computer.
Performance Options...
Environment Variables
Environment variables tell your computer where to find certain types of information.
Environment Variables...
Startup and Recovery
Startup and recovery options tell your computer how to start and what to do if an error causes your computer to stop.
Startup and Recovery...
OK
Cancel
Apply

Figure A.65 Advanced Page on the System Properties Dialog

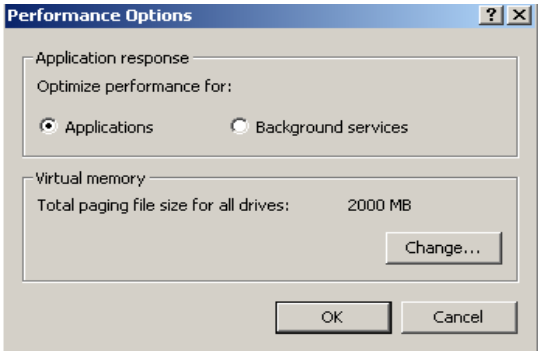


Figure A.66 Performance Options Dialog

4. In the **Drive** list, click the drive that contains the paging file you want to change. (Figure A.67)

5. Under **Paging file size for selected drive**, type a new paging file size in megabytes in the **Initial size (MB)** or **Maximum size (MB)** box, and then click **Set**. (Figure A.67)

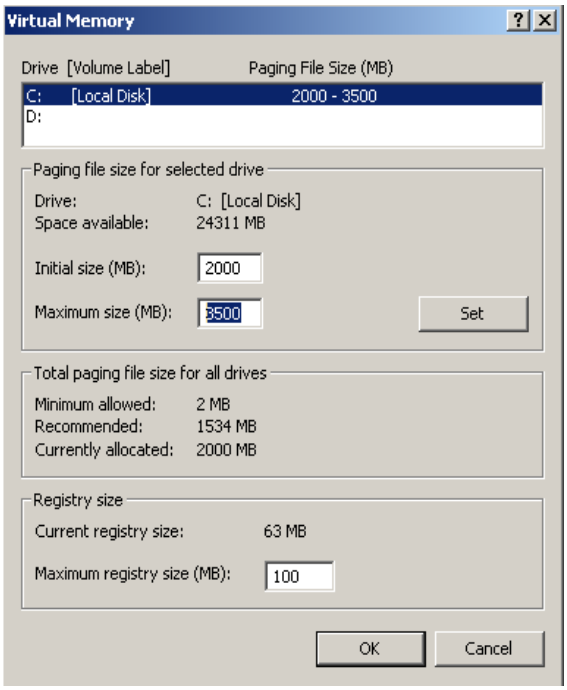


Figure A.67 Virtual Memory Settings

For best performance, set the initial size to not less than the recommended size under **Total paging file size for all drives**. The recommended size is equivalent to 1.5 times the amount of RAM on your system. If you cannot change the file size or cannot resolve the "out-of memory" error by increasing the page file size, consider creating smaller.

A.6 Setting the HAZUS-MH Default Data On The Local Hard Drive

The following procedure was developed to allow the user to improve the study region processing time by taking the data off the DVD, where DVD read time may negatively impact the study region processing time, and loading the data onto a local hard drive or network drive.

To set up this effort, please create a folder on the hard drive of the target computer. It is suggested that you use a name that can be quickly recognized such as DVD Data For HAZUS. Copy the syBoundary.mdb to the root of this directory. Then copy the state or states of interest into the directory. Figure A.68 shows the arrangement currently used by ABS. In Figure A.68, please note the location of syBoundary.mdb in relation to the state data folders. Also please note the small text files that **HAZUS** requires (i.e. A1.txt, B1.txt, etc.). There is one text file per DVD.

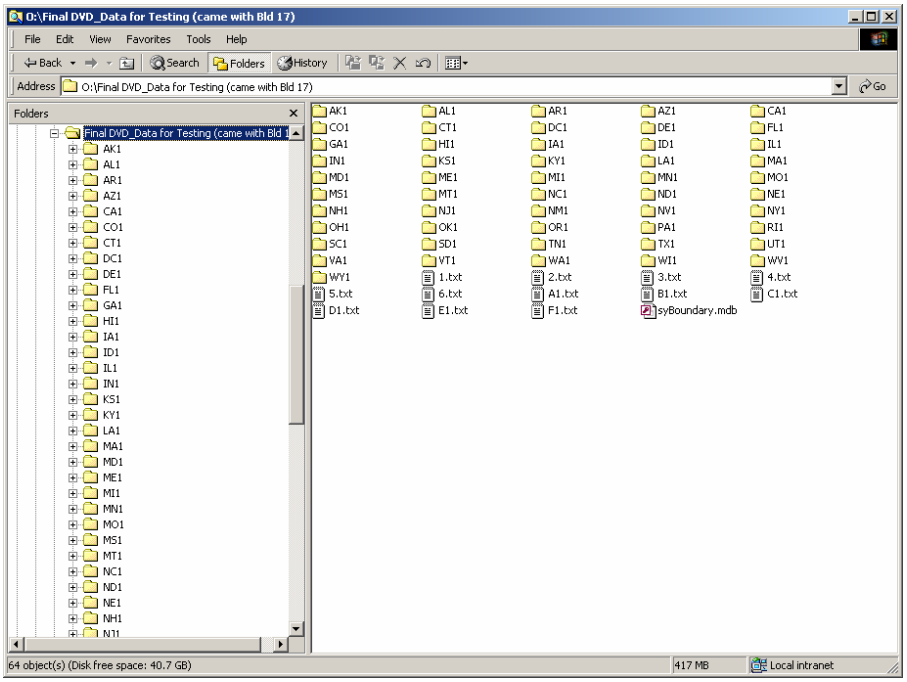

O:\Final DVD_Data for Testing (came with Bld 17)
File Edit View Favorites Tools Help
Back Search Folders History
Address O:\Final DVD_Data for Testing (came with Bld 17)
Go
Folders
Final DVD_Data for Testing (came with Bld 1
AK1 AL1 AR1 AZ1 CA1
CO1 CT1 DC1 DE1 FL1
GA1 HI1 IA1 ID1 IL1
IN1 KS1 KY1 LA1 MA1
MD1 ME1 MI1 MN1 MO1
MS1 MT1 NC1 ND1 NE1
NH1 NJ1 NM1 NV1 NY1
OH1 OK1 OR1 PA1 RI1
SC1 SD1 TN1 TX1 UT1
VA1 VT1 WA1 WI1 WV1
WY1 1.txt 2.txt 3.txt 4.txt
5.txt 6.txt A1.txt B1.txt C1.txt
D1.txt E1.txt F1.txt syBoundary.mdb
64 object(s) (Disk free space: 40.7 GB)
417 MB
Local intranet

Figure A.68 Suggested Set-up for DVD Data on a Hard Drive

Once the DVD data is located onto the hard drive (and this can be a network drive as ABS has done in Figure A.68 above) you need to modify the registry to point to the file. This is easily accomplished through the use of regedit. To launch regedit go the Windows Start button, select Run…as seen in Figure A.69 below.

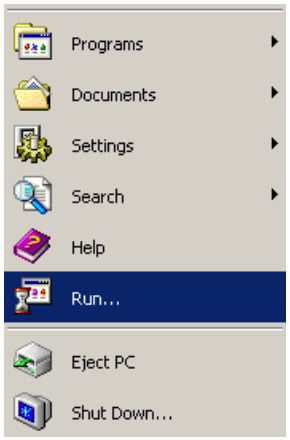


Figure A.69 Run…Option on the Start Menu

The dialog seen if Figure A.70 should open and you will need to enter regedit as shown.

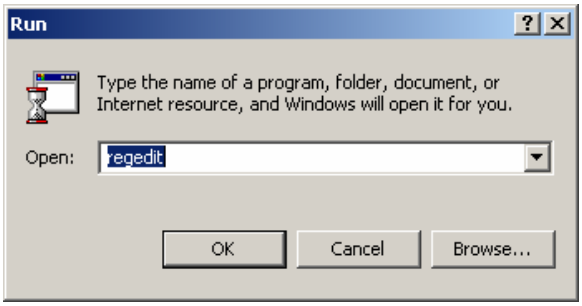


Figure A.70 Run…Dialog Input

Upon selection of **OK**, you should see the dialog shown in Figure A.71 below.

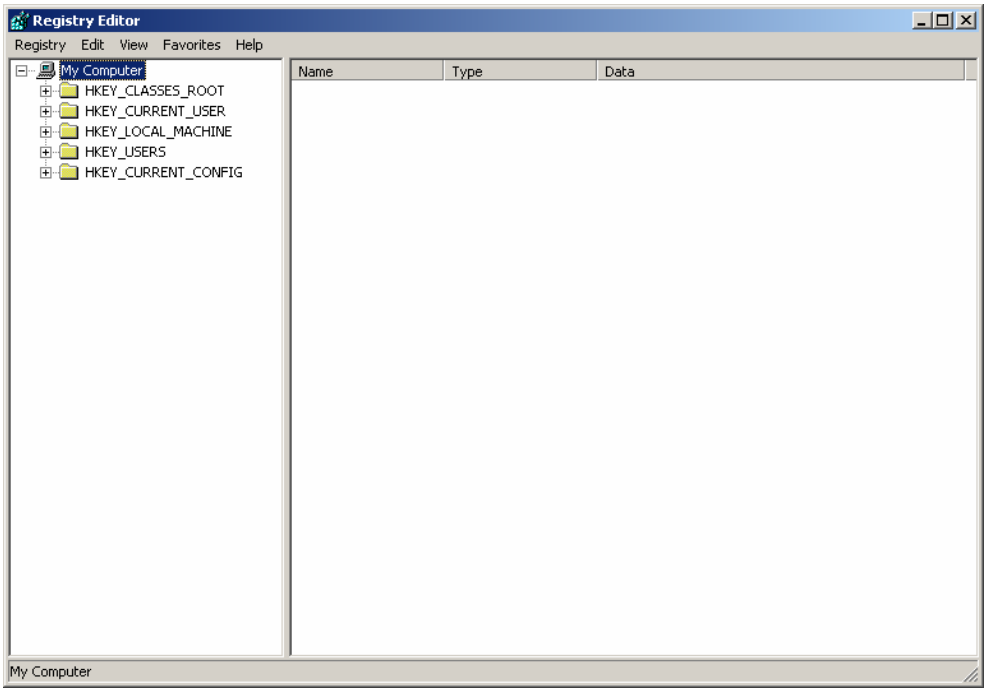


Figure A.71 The regedit Dialog

You should expand the folder HKEY_LOCAL_MACHINE. This will allow you to view another layer of folders to navigate through as seen in Figure A.72.

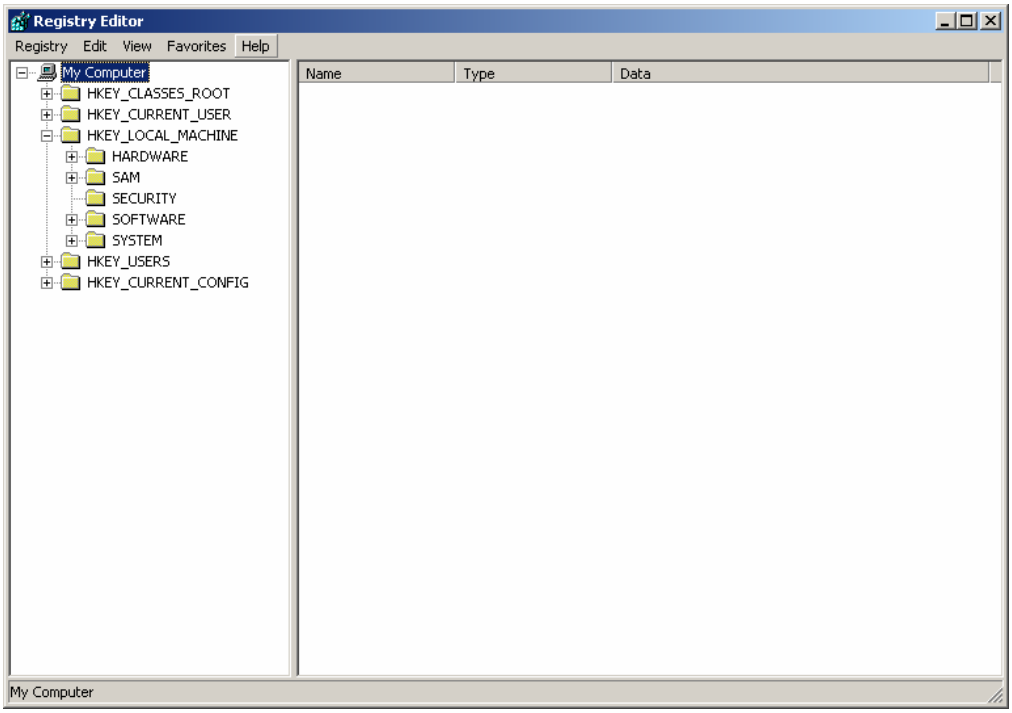


Figure A.72 Expanded View of the HKEY_LOCAL_MACHINE Folder

At this point, expand the SOFTWARE Folder to view all of the local software packages on the machine in question. Specifically you are looking for the FEMA folder seen in Figure A.73 below.

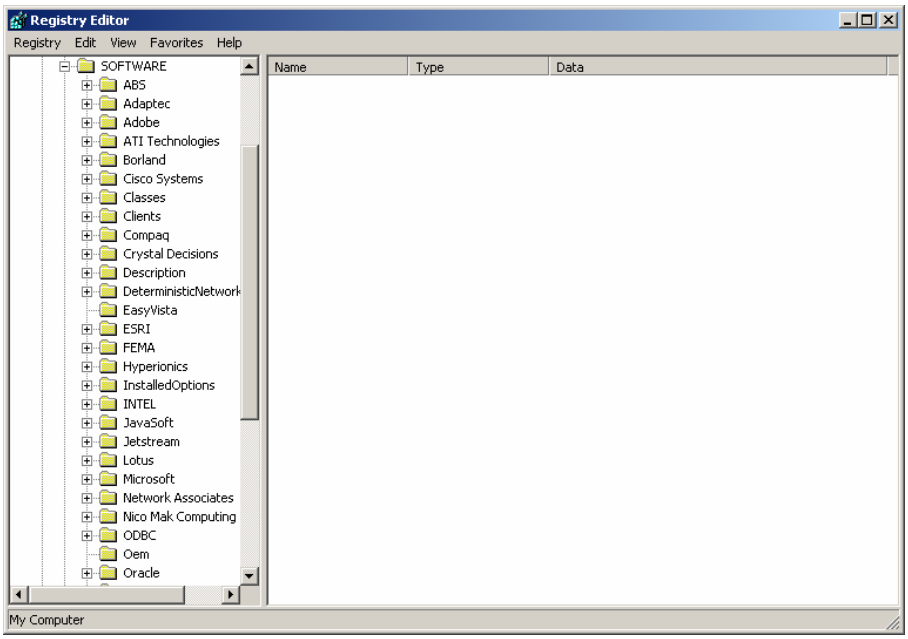


Figure A.73 Expanded View of the SOFTWARE Folder

Expanding the FEMA folder, you will see the folders seen in Figure A.74. The folder of choice is the General Folder, which contains the registries of interest.

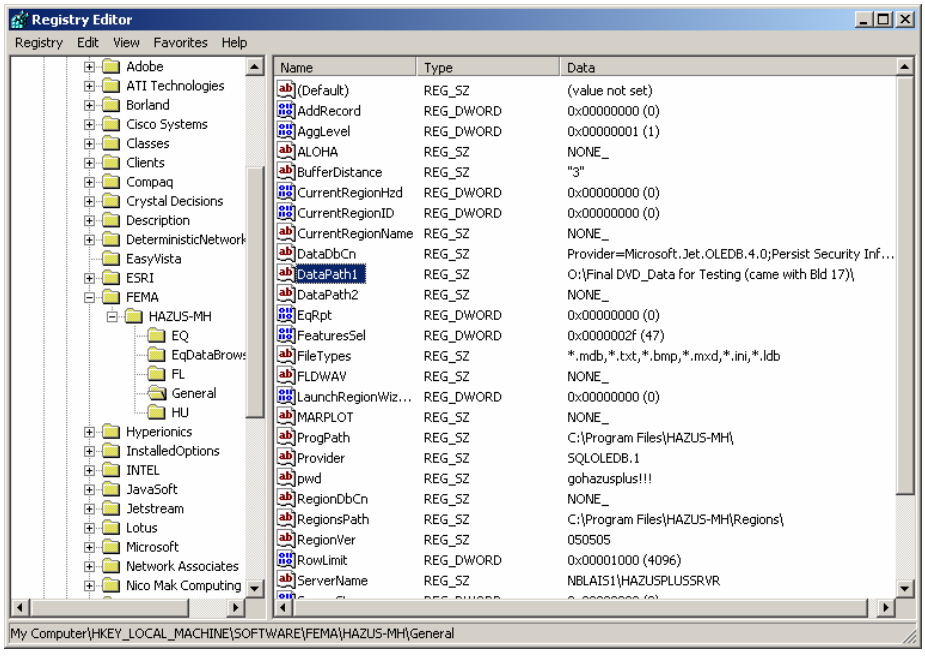


Figure A.74 Expansion of the FEMA Folder and Selection of the General Folder

As seen in Figure A.74, there is a field labeled DataPath1. This is the registry that must be changed to reflect the desired data location. Double clicking on the name DataPath1 will open the dialog seen in Figure A.75.

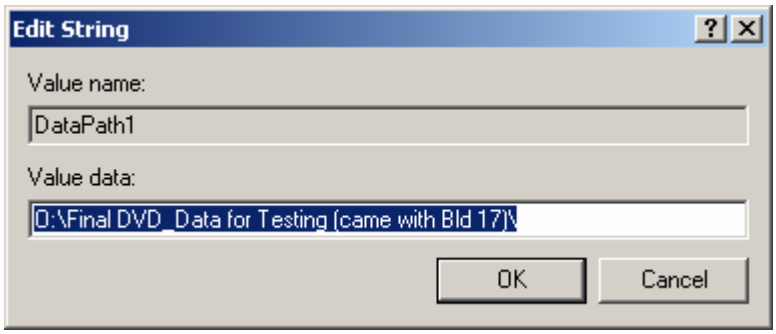


Figure A.75 Changing the DataPath1 Registry

NOTE: It is very important to place the ***trailing backslash*** on the end of the path name otherwise the program will not look inside the folder for your data.

Click **OK** then exit regedit and you are ready to use the data on the network or the hard drive of choice.

Appendix B. Flood Specific Building Classification System

For the application of the building damage functions, the flood model expands the 33 specific occupancies into a distribution that accounts for the number of stories and the foundation types (33 Specific Occupancies x 3 or 4 Number of Stories x 7 Foundation Types). These specific building classes used in the Flood Model are listed and briefly described in Table B.1. Each identifier begins with the 2-3 character abbreviated Specific Occupancy (i.e., C10 for COM10, R1 for RES1, R3A for RES3A, RE1 for REL1, etc.), 1 letter for number of stories (e.g., 1, or 2, for residential or L, M for non-residential), and 1 letter for basement or no basement (B, N).

To modify these distributions, the Flood Model provides the user a dialog under the Inventory menu, General Building Stock submenu called the Flood Specific Occupancy Mapping Scheme. The user can change the parameters in this dialog for use throughout the model. Default mapping schemes are provided for the states covered by the Flood Model, but these can be modified on a state, county, or census tract basis if the user has access to more accurate information in his or her geographic area of interest.

Table B.1 Specific Occupancies

Specific Occupancy	Specific Occupancy Description
RES1	Single Family Dwelling
RES2	Manufactured Home
RES3A	Multi Family Dwelling A (Duplex)
RES3B	Multi Family Dwelling B (Triplex-Quad)
RES3C	Multi Family Dwelling C (5-9 units)
RES3D	Multi Family Dwelling D (10-19 units)
RES3E	Multi Family Dwelling E (20-49 units)
RES3F	Multi Family Dwelling F (50+ units)
RES4	Temporary Lodging (e.g., Hotel)
RES5	Institutional Dormitory
RES6	Nursing Home
COM1	Retail Trade
COM2	Wholesale Trade
COM3	Personal and Repair Service
COM4	Financial/Professional/Technical Services
COM5	Banks
COM6	Hospitals
COM7	Medical Offices/Clinic
COM8	Entertainment & Recreation
COM9	Theaters
COM10	Parking

Table B.1 Specific Occupancies (Continued)

Specific Occupancy	Specific Occupancy Description
IND1	Heavy
IND2	Light
IND3	Food/Drug/Chemical
IND4	Metals/Minerals Processing
IND5	High Technology
IND6	Construction
AGR1	Agriculture
REL1	Church
GOV1	General Services
GOV2	Emergency Response
EDU1	Schools
EDU2	Colleges/Universities
Number of Stories Residential	
1 Story	
2 Story	
3+ Story	
Split Level	
Number of Stories Non-Residential	
High Rise	
Low Rise	
Mid Rise	
Single Family	
RES1 1-Story	No Basement R11N
RES1 1-Story	Basement R11B
RES1 2-Story	No Basement R12N
RES1 2-Story	Basement R12B
RES1 3-Story	No Basement R13N
RES1 3-Story	Basement R13B
RES1 Split Level	No Basement R1SN
RES1 Split Level	Basement R1SB
Manufactured Housing	
RES2 1-Story	No Basement R21N
RES2 1-Story	Basement R21B
Multi-Family	
RES3A 1-2 Story	No Basement R3A1N
RES3A 1-2 Story	Basement R3A1B
RES3A 3-4 Story	No Basement R3A3N
RES3A 3-4 Story	Basement R3A3B
RES3A 5+ Story	No Basement R3A5N
RES3A 5+ Story	Basement R3A5B

Table B.1 Specific Occupancies (Continued)

Multi-Family	
RES3B 1-2 Story	No Basement R3B1N
RES3B 1-2 Story	Basement R3B1B
RES3B 3-4 Story	No Basement R3B3N
RES3B 3-4 Story	Basement R3B3B
RES3B 5+ Story	No Basement R3B5N
RES3B 5+ Story	Basement R3B5B
RES3C 1-2 Story	No Basement R3C1N
RES3C 1-2 Story	Basement R3C1B
RES3C 3-4 Story	No Basement R3C3N
RES3C 3-4 Story	Basement R3C3B
RES3C 5+ Story	No Basement R3C5N
RES3C 5+ Story	Basement R3C5B
RES3D 1-2 Story	No Basement R3D1N
RES3D 1-2 Story	Basement R3D1B
RES3D 3-4 Story	No Basement R3D3N
RES3D 3-4 Story	Basement R3D3B
RES3D 5+ Story	No Basement R3D5N
RES3D 5+ Story	Basement R3D5B
RES3E 1-2 Story	No Basement R3E1N
RES3E 1-2 Story	Basement R3E1B
RES3E 3-4 Story	No Basement R3E3N
RES3E 3-4 Story	Basement R3E3B
RES3E 5+ Story	No Basement R3E5N
RES3E 5+ Story	Basement R3E5B
RES3F 1-2 Story	No Basement R3F1N
RES3F 1-2 Story	Basement R3F1B
RES3F 3-4 Story	No Basement R3F3N
RES3F 3-4 Story	Basement R3F3B
RES3F 5+ Story	No Basement R3F5N
RES3F 5+ Story	Basement R3F5B
Other Residential	
RES4 Low Rise	No Basement R4LN
RES4 Low Rise	Basement R4LB
RES4 Mid Rise	No Basement R4MN
RES4 Mid Rise	Basement R4MB
RES4 High Rise	No Basement R4HN
RES4 High Rise	Basement R4HB
RES5 Low Rise	No Basement R5LN
RES5 Low Rise	Basement R5LB
RES5 Mid Rise	No Basement R5MN
RES5 Mid Rise	Basement R5MB
RES5 High Rise	No Basement R5HN
RES5 High Rise	Basement R5HB

Table B.1 Specific Occupancies (Continued)

Other Residential	
RES6 Low Rise	No Basement R6LN
RES6 Low Rise	Basement R6LB
RES6 Mid Rise	No Basement R6MN
RES6 Mid Rise	Basement R6MB
RES6 High Rise	No Basement R6HN
RES6 High Rise	Basement R6HB
Non-Residential	
COM1 Low Rise	No Basement C1LN
COM1 Low Rise	Basement C1LB
COM1 Mid Rise	No Basement C1MN
COM1 Mid Rise	Basement C1MB
COM1 High Rise	No Basement C1HN
COM1 High Rise	Basement C1HB
COM2 Low Rise	No Basement C2LN
COM2 Low Rise	Basement C2LB
COM2 Mid Rise	No Basement C2MN
COM2 Mid Rise	Basement C2MB
COM2 High Rise	No Basement C2HN
COM2 High Rise	Basement C3HB
COM3 Low Rise	No Basement C3LN
COM3 Low Rise	Basement C3LB
COM3 Mid Rise	No Basement C3MN
COM3 Mid Rise	Basement C3MB
COM3 High Rise	No Basement C3HN
COM3 High Rise	Basement C3HB
COM4 Low Rise	No Basement C4LN
COM4 Low Rise	Basement C4LB
COM4 Mid Rise	No Basement C4MN
COM4 Mid Rise	Basement C4MB
COM4 High Rise	No Basement C4HN
COM4 High Rise	Basement C4HB
COM5 Low Rise	No Basement C5LN
COM5 Low Rise	Basement C5LB
COM5 Mid Rise	No Basement C5MN
COM5 Mid Rise	Basement C5MB
COM5 High Rise	No Basement C5HN
COM5 High Rise	Basement C5HB
COM6 Low Rise	No Basement C6LN
COM6 Low Rise	Basement C6LB
COM6 Mid Rise	No Basement C6MN
COM6 Mid Rise	Basement C6MB
COM6 High Rise	No Basement C6HN
COM6 High Rise	Basement C6HB

Table B.1 Specific Occupancies (Continued)

Non-Residential	
COM7 Low Rise	No Basement C7LN
COM7 Low Rise	Basement C7LB
COM7 Mid Rise	No Basement C7MN
COM7 Mid Rise	Basement C7MB
COM7 High Rise	No Basement C7HN
COM7 High Rise	Basement C7HB
COM8 Low Rise	No Basement C8LN
COM8 Low Rise	Basement C8LB
COM8 Mid Rise	No Basement C8MN
COM8 Mid Rise	Basement C8MB
COM8 High Rise	No Basement C8HN
COM8 High Rise	Basement C8HB
COM9 Low Rise	No Basement C9LN
COM9 Low Rise	Basement C9LB
COM9 Mid Rise	No Basement C9MN
COM9 Mid Rise	Basement C9MB
COM9 High Rise	No Basement C9HN
COM9 High Rise	Basement C9HB
COM10 Low Rise	No Basement C10LN
COM10 Low Rise	Basement C10LB
COM10 Mid Rise	No Basement C10MN
COM10 Mid Rise	Basement C10MB
COM10 High Rise	No Basement C10HN
COM10 High Rise	Basement C10HB
IND1 Low Rise	No Basement I1LN
IND1 Low Rise	Basement I1LB
IND1 Mid Rise	No Basement I1MN
IND1 Mid Rise	Basement I1MB
IND1 High Rise	No Basement I1HN
IND1 High Rise	Basement I1HB
IND2 Low Rise	No Basement I2LN
IND2 Low Rise	Basement I2LB
IND2 Mid Rise	No Basement I2MN
IND2 Mid Rise	Basement I2MB
IND2 High Rise	No Basement I2HN
IND2 High Rise	Basement I2HB
IND3 Low Rise	No Basement I3LN
IND3 Low Rise	Basement I3LB
IND3 Mid Rise	No Basement I3MN
IND3 Mid Rise	Basement I3MB
IND3 High Rise	No Basement I3HN
IND3 High Rise	Basement I3HB

Table B.1 Specific Occupancies (Continued)

Non-Residential	
IND4 Low Rise	No Basement I4LN
IND4 Low Rise	Basement I4LB
IND4 Mid Rise	No Basement I4MN
IND4 Mid Rise	Basement I4MB
IND4 High Rise	No Basement I4HN
IND4 High Rise	Basement I4HB
IND5 Low Rise	No Basement I5LN
IND5 Low Rise	Basement I5LB
IND5 Mid Rise	No Basement I5MN
IND5 Mid Rise	Basement I5MB
IND5 High Rise	No Basement I5HN
IND5 High Rise	Basement I5HB
IND6 Low Rise	No Basement I6LN
IND6 Low Rise	Basement I6LB
IND6 Mid Rise	No Basement I6MN
IND6 Mid Rise	Basement I6MB
IND6 High Rise	No Basement I6HN
IND6 High Rise	Basement I6HB
REL1 Low Rise	No Basement RE1LN
REL1 Low Rise	Basement RE1LB
REL1 Mid Rise	No Basement RE1MN
REL1 Mid Rise	Basement RE1MB
REL1 High Rise	No Basement RE1HN
REL1 High Rise	Basement RE1HB
AGR1 Low Rise	No Basement A1LN
AGR1 Low Rise	Basement A1LB
AGR1 Mid Rise	No Basement A1MN
AGR1 Mid Rise	Basement A1MB
AGR1 High Rise	No Basement A1HN
AGR1 High Rise	Basement A1HB
GOV1 Low Rise	No Basement G1LN
GOV1 Low Rise	Basement G1LB
GOV1 Mid Rise	No Basement G1MN
GOV1 Mid Rise	Basement G1MB
GOV1 High Rise	No Basement G1HN
GOV1 High Rise	Basement G1HB
GOV2 Low Rise	No Basement G2LN
GOV2 Low Rise	Basement G2LB
GOV2 Mid Rise	No Basement G2MN
GOV2 Mid Rise	Basement G2MB
GOV2 High Rise	No Basement G2HN
GOV2 High Rise	Basement G2HB

Table B.1 Specific Occupancies (Continued)

Non-Residential	
EDU1 Low Rise	No Basement E1LN
EDU1 Low Rise	Basement E1LB
EDU1 Mid Rise	No Basement E1MN
EDU1 Mid Rise	Basement E1MB
EDU1 High Rise	No Basement E1HN
EDU1 High Rise	Basement E1HB
EDU2 Low Rise	No Basement E2LN
EDU2 Low Rise	Basement E2LB
EDU2 Mid Rise	No Basement E2MN
EDU2 Mid Rise	Basement E2MB
EDU2 High Rise	No Basement E2HN
EDU2 High Rise	Basement E2HB

Appendix C. Using HAZUS for Specific Policy Applications

HAZUS can be used to aid decision makers in managing floodplains. This appendix provides six examples of using **HAZUS** to estimate the impacts of various floodplain regulations.

C.1 Impacts of Construction Regulations in Floodplains

This example demonstrates how the user can determine the impacts of the creation of modification of the floodplain regulatory requirements. The example analyzes the impact of requiring that every house within the floodplain be either built or retrofitted to BFE+1 foot. The example includes a Level 1 analysis using the baseline general building stock data, and a Level 2 analysis using site-specific user-defined building inventory data.

In order to start the process, the user can run an analysis using the default mapping scheme to determine a baseline. For example, a community that is trying to identify the losses avoided from joining the NFIP program in 1980, could run the analysis with the default pre-FIRM settings and develop losses. To then determine the losses avoided, the Level 1 user should adjust the foundation heights using the *Flood Mapping Scheme* dialogs to simulate the implementation of floodplain regulations. The Flood Mapping Scheme dialogs are as appears in Figure C.1 below.

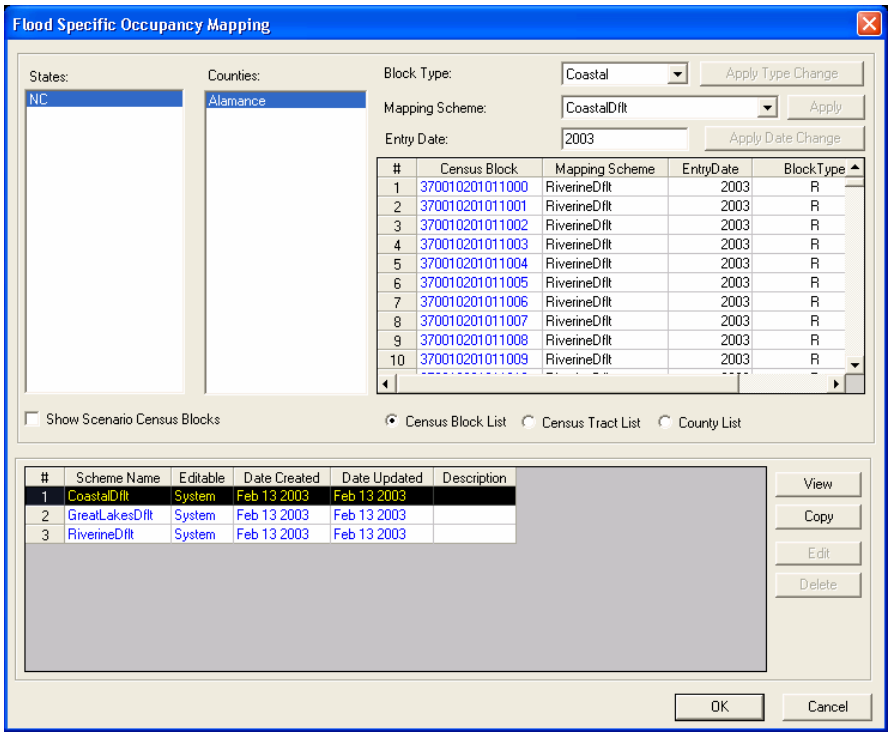


Figure C.1 Flood Specific Occupancy Mapping

Once the user defined occupancy mapping has been created, as seen in Figure C.2 below, the user should edit the foundation heights to meet the BFE to which they are interested in regulating, or are regulating to.

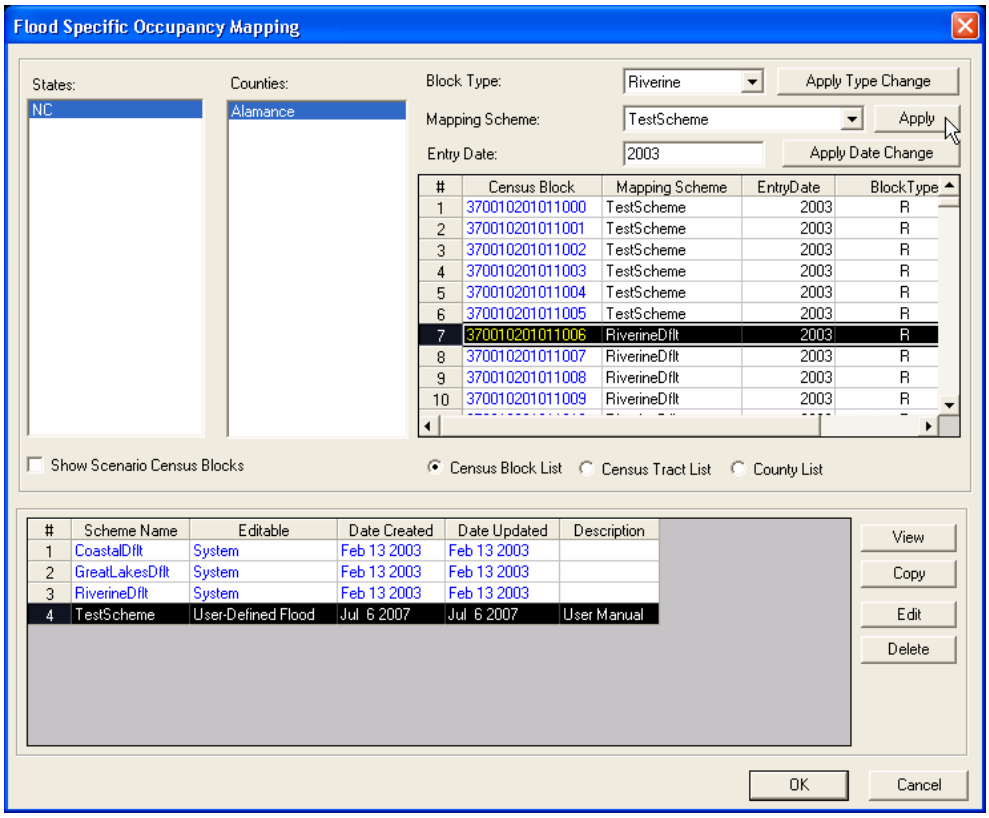


Figure C.2 Flood Specific Occupancy Mapping Characteristics User Copy

For example in Figure C.3 below the user has changed the Post-FIRM foundation heights to closely reflect a requirement to exceed a BFE of 4-feet by one foot. The user should also be aware to ensure that foundation types that become restricted because of this requirement are set to zero. In other words, the requirement to have a first floor height of at least 5-feet indicates that slab on grade foundations are not likely to be used, and other foundation types such as fill are limited in their use.

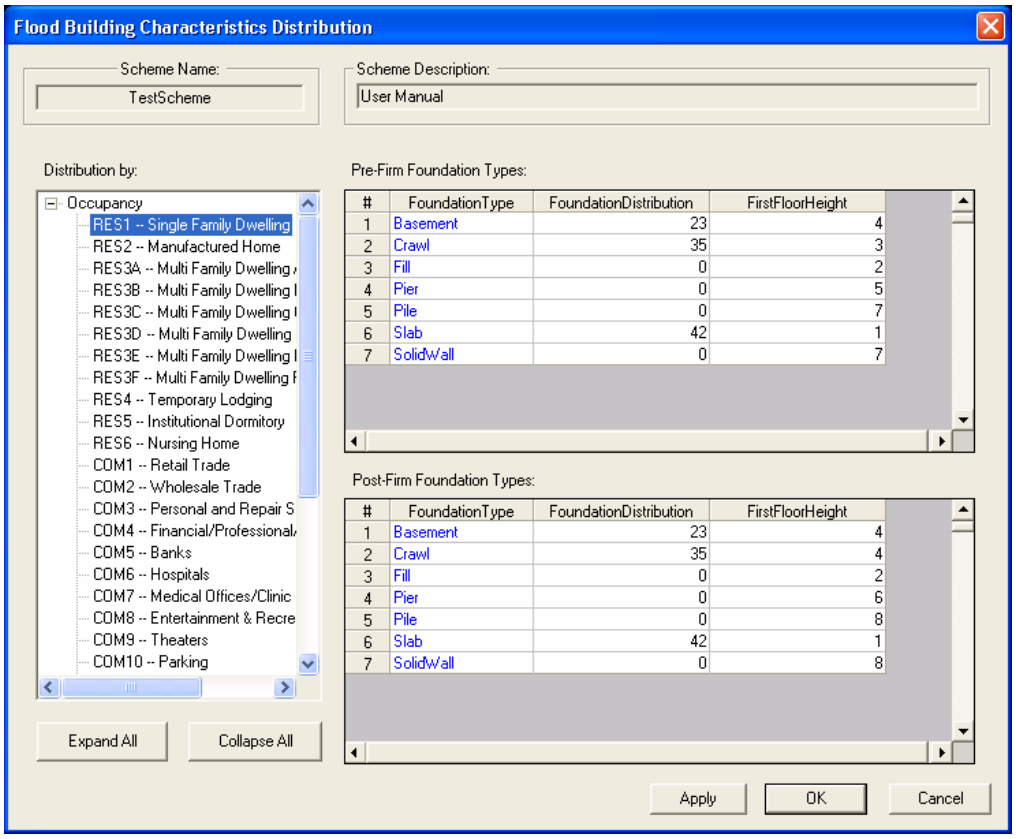


Figure C.3 Building Characteristics

The user would then create or duplicate the previous scenario (where the user calculated all Pre-FIRM foundations) and re-run the analysis using the user defined *Flood Mapping Occupancy Scheme* and compare the results. This can be done by exporting the results into Excel or MS Access.

The Level 2 user has the advantage of using the *User Defined* data with the associated detailed information such as foundation height. As with the Level 1 user, the user would start by running a baseline analysis using the data as brought into **HAZUS.** This could be done using the Inventory Collection and Survey Tool (InCAST) or by importing a dataset previously formatted with the necessary information into the *User Defined* facility tables. The reader should refer to the InCAST User Manual for directions on how to use that tool. The baseline analysis will later be compared to results with using the modified inventory.

The modification is simple. The user can ether perform a query in the initial database and create a duplicate database with the foundations elevated to meet the BFE+1-foot requirement. The revised data will then be analyzed and the results compared and the results can be defined as the losses avoided by the modification of the inventory.

C.4 Impacts of Remapping Studies

This example demonstrates the use of **HAZUS** to analyze losses through the use of updated floodplain boundaries that result from floodplain mapping re-studies. The purpose is to demonstrate the value of re-mapping in land use planning and the resultant reduction in flood losses. The use of **HAZUS** to analyze potential losses under current and future land use scenarios is a valuable tool for policy makers.

For this analysis, the user would utilize the Flood Information Tool (FIT) to prepare their new study for use in the flood model. If possible, the user should also prepare the previous flood study for use in the flood model. If the original floodplain is in hardcopy or paper format, the user will need to digitize the maps. When digitizing, the user should ensure that the floodplain boundary is saved as an ArcGIS polygon and the Base Flood Elevation (BFE) lines are digitized as ArcGIS polylines attributed with the BFE elevation.

The process would be as follows:

1. Create one study region and duplicate the region, or create two duplicate regions where the user is interested in studying the differences between the two studies.

2. Prepare the original flood study (if the data is available) or digitize the flood maps as noted above using the FIT.

3. Prepare the restudy for use in the flood model. If the data is available in digital format, the user should ensure that the data is registered and process it through the FIT in preparation for use in the flood model.

4. Once the two datasets are prepared, the user can use the *Hazard* Menu, *User Data* submenu, and *FIT* tab to point to the created FIT areas. It is suggested that the user assign one region to the original study and another region to the restudy.

5. Analyze the original flood study, either with the default **HAZUS** data, or with local input data such as a county assessor data processed through the Building Import Tool (BIT). This analysis should occur in one of the study regions created in the Step 1 above. The user should make sure that the inventories analyzed within the two regions are the same in order to ensure that the results represent the difference in the studies.

6. Analyze the restudy using study region 2 created in Step 1. The inventories should be the same inventory used in Step 5 above.

7. The user can use an ODBC connection through MS Access and link to the two databases and query the two results tables to draw a direct comparison. The tables to be linked are

identified as flFRGBSEcLossTotal. The tables contain the total loss by census block for the two regions. Other tables provide the user with differences by occupancy and by building type, but the initial assessment should be based on the total difference. Other tables can be found in the Data Dictionary of the Flood Model User Manual.

There is no duplicate process for the Level 1 user. For assistance in processing the flood study data through the Flood Information Tool, the user should refer to the Flood Information Tool User Manual.

C.5 Impacts of Structure Acquisition and Removal

In this example the effects of the acquisition and removal of a single structure or a small number of structures on flood losses will be analyzed. The example discusses how the user prepares the flood hazard data within the FIT, utilizes the InCAST (Inventory and Collection Tool) to prepare the inventory data, and imports the data into **HAZUS**. The example also demonstrates estimating annualized losses in the study area within and without the targeted structures.

Buyout and acquisition programs are one of the leading approaches for reducing a community flood risk. The buyout program is most effective after a flood event, when people are more willing to relocate away from the floodplain, but communities should be mindful that a buyout program could occur at any time should the homeowner be willing to sell. The flood model will provide the user with an opportunity to identify those structures that are the best candidates for acquisition based on their exposure to flooding of different return periods or repetitive loss nature. For example one home that has the possibility of flooding from a 50-year flood and higher is a better candidate for acquisition than a home that is not likely to flood until the 100-year event.

While the user can use the Level 1 hazard for this analysis (i.e. using the default DEM, hydrology and hydraulics), it is not recommended that this analysis be the basis for determining the best candidates for an acquisition program unless no other studies are available. It is recommended that the user utilize the FIT tool and bring in a more accurate flood study to perform this analysis.

Recommendations for this analysis include: 1) using a high quality DEM and not the default USGS 1 arc-second data, 2) use a high quality flood study, preferably one done with the same DEM noted previously and it is preferred to use an HEC analysis, and 3) use GPS technology to identify the locations of the structures.

The user should use the Inventory Collection and Survey Tool (InCAST) to capture the location, structure types, and occupancies of all structures of interest. In order to ensure the most accurate assessment of the losses and potential exposure to flooding, it is recommended that a Global Positioning Unit (GPS) be used to identify the location of the building within its parcel. With this location, the flood model can determine the depth of flooding at the location. It is also important to note the foundation type and subsequent first floor height. NOTE: The InCAST has a field for first floor elevation. The user will need to convert this to a height (either using a DEM or by also capturing the height at the time of the site visit). With the buildings loaded into

the User Defined facility tables, the user should create a study region and select the FIT areas of interest.

The user then has two options that are really driven by the availability of data. Assuming that the user has been able to process their FIT analysis has three return periods and the associated discharge values, the user can compute perform an annualized loss estimate and develop their "benefit/loss" based on the annualized loss. To do this, the user must first perform the hazard assessment with enough return periods for the annualized loss. Under the *Hazard* menu, *Riverine* or *Coastal* submenu, *Delineate Floodplain* submenu, the user would select the Annualized Loss hazard assessment. Once this has been completed, the user may the select the *Annualized Loss* submenu on the *Analysis* menu. The final results present to the user the probable annualized loss that might be exceeded in a given year.

If the user does not have multiple return periods and/or discharges, it is recommended that the user perform a similar analysis for the available return period (most likely 100-year) and determine the loss for the structures. The results of this analysis will become the baseline for the analysis of the benefits of acquisition.

The user can return to the *Inventory* Menu, *User Defined Facilities* submenu, and either delete the structures targeted for the acquisition program, or reduce the square footage to 1-foot thereby leaving the facility in the database. The user can then create a new scenario and reselect the FIT areas for a repeat of the previous analysis. Comparison of the results will provide the user with the necessary information to determine if an acquisition program has a potential positive benefit.

C.6 Impacts of Regulating Stream Flow

The default hydrologic analyses apply to unregulated drainage areas. Regulation, through diversions and/or storage, changes the flood frequency curves downstream. **HAZUS** provides a tool for incorporating the downstream effects of flow regulation. The tool allows users to modify the unregulated flood frequency curve at a specific location by entering one or more pairs of recurrence intervals and discharge values. **HAZUS** identifies downstream reaches affected, and modifies the corresponding flood frequency curves as appropriate.

Users identify, with the mouse, the location of a regulating structure, such as a flood control reservoir. The algorithm finds the drainage area upstream of that location and defines the unregulated flood frequency curve. The curve is plotted and a table of recurrence intervals and associated discharge values is presented for the user to peruse and modify.

As the user enters and/or modifies values in the table, both the curve and the table are revised to reflect the changes. The first modification results in revising all discharge values associated with recurrence intervals (frequencies) less (greater) than the user supplied recurrence interval to be no greater than the modified discharge value. Graphically, the curve is revised by drawing a horizontal line from the modified point to the point where that line intersects the unregulated curve. The curve is not revised for recurrence intervals greater than recurrence interval of the user supplied point. Thus, graphically, a vertical line is drawn from the modified point to the point where that line intersects the unregulated curve.

For example, Figure C.4 shows the unregulated flood frequency curve associated with the most downstream reach of the North Fork of the Shenandoah River. The drainage area there is approximately 1320 square miles.

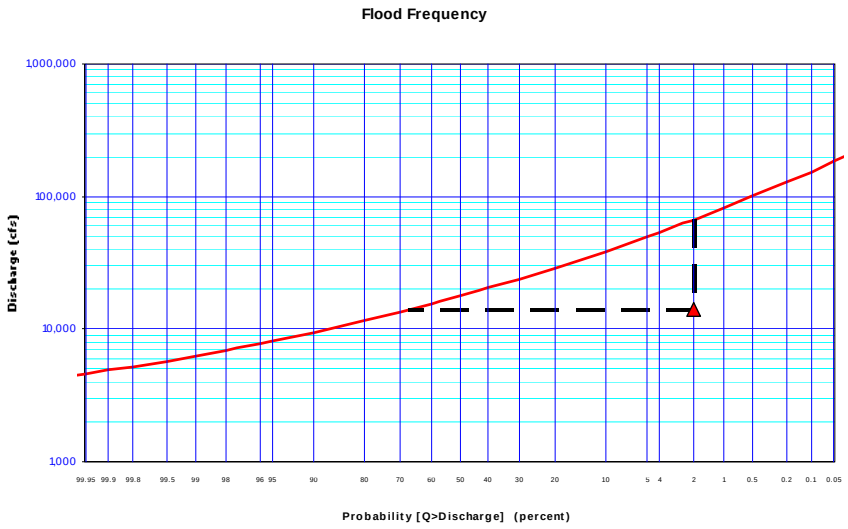


Figure C.4 Flood Frequency Curve

Consider the ramifications of placing a dam within the reach and controlling the outflow at 14,000 cubic feet per second (cfs). The dam would be large enough to control up to a 50-year flood. The regulated flood frequency curve at the outflow point is shown on Figure C.4. The revised part is shown as the dashed line. The modification was accomplished by entering a 50-year discharge value of 14,000 cfs, shown as the triangle on the curve.

Subsequent modifications are incorporated by assuming a lognormal distribution (straight line on the graph) between points. Again, the point associated with the smallest modified recurrence interval is connected to the unregulated flood frequency curve with a line of constant discharge value (horizontal line). The point associated with the greatest modified recurrence interval is connected to the unregulated curve with a line of constant frequency (vertical line).

The algorithm translates the effects downstream by assuming that the contribution to the unregulated flow at some point coming from any portion of the drainage area is proportional to the size of that portion. That is, a 132 square-mile area contributes 10 percent of the flow to our example reach. For a given recurrence interval, the reduction in flow at some point resulting from upstream regulation is determined as follows:

- The unregulated flow value is determined at the point.
- That value is multiplied by the ratio of the drainage areas of the regulated site and the point. The product is the unregulated contribution from the regulated site.

- The frequency associated with that unregulated contribution is determined.
- The regulated flow value associated with that frequency is determined and subtracted from the unregulated value.

That difference is the reduction in flow at the point resulting from the upstream regulation.

The South Fork of the Shenandoah River joins the North Fork to form the Shenandoah River at the downstream node of our example reach. The drainage area there is approximately 3000 square miles. The 100-year flood discharge is approximately 142,750 cfs. In the algorithm, the contribution from the North Fork is 62,810 cfs, a little less than the 50-year flood discharge value. The regulated flow at the potential dam site is 14,000 cfs and, therefore the reduction is 48,810 cfs. The effects of the dam downstream at the upstream node of the Shenandoah River would be to reduce the 100-year flood discharge value from 142,750 to about 93,940 cfs.

Such an analysis including the accompanying loss estimation in **HAZUS** can be used to justify a more detailed investigation into regulating the flow some upstream.

C.7 Impacts of Building Levees

In general, DEMs are not reliable for identifying a continuous embankment with relatively little width. Because grid cells are connected at the corners as well as the sides, an embankment that is not a straight line, in the strictest sense, must be at least two cells wide to be treated as a barrier to flow. A tool is available in **HAZUS** to add a levee alignment, attribute the levee with a level of protection and, for Level 1 analyses determine (within the limits of a level 1 analysis) the effects of a levee on flood depths within the unprotected portion of the floodplain.

In areas identified as protected by a levee, flood depths are zero for frequencies up to the recurrence interval of the level of protection provided by the levee. For recurrence intervals exceeding the level of protection, flood depths are those computed without consideration of the levee. Similarly, if the option to determine the ramifications of a levee is chosen, two sets of flood depth grids are created: one with the levee and one without the levee reflected in the DEM.

The levee option is applied by drawing a polyline with the mouse. Flood depth grids have been created for the reach and the user chooses a grid on which to draw the levee alignment. The alignment should cross the floodplain twice. The user is prompted to supply the recurrence interval, in years, corresponding to the level of protection provided by the levee.

If a flood depth grid has been created corresponding to the level of protection or if enough grids have been created to interpolate that particular grid, the floodplain associated with that grid is determined. The levee alignment and section of that floodplain between the points where the alignment crosses the floodplain are used to define a polygon. If the floodplain associated with the recurrence interval cannot be determined, the floodplain associated with the flood depth grid chosen to draw the alignment is used to define the polygon.

If the levee alignment does not cross the floodplain twice the user is notified and cautioned that the floodplain information and supplied levee alignment indicate that the levee does not provide the entered level of protection.

If flood depth grids were developed with Level 1 analyses, the user may choose to re-create the depth grids with the levee represented in the DEM. Note that because the default hydraulic analyses are performed using normal depth calculations (*i.e.*, no consideration of backwater effects), flood elevations and, consequently, flood depths and the extent of floodplains will change only at cross sections within the levied portion of the reach. The effects of the levee on upstream cross sections will not be reflected.

If the user chooses to investigate the local increases in flood depths resulting from a levee alignment, a buffer is created one cell size around the user-supplied polyline. The resulting polygon is attributed with a high elevation value and a grid is created from the polygon. Note that the grid, or levee, is everywhere at least two cells wide. That grid is merged with the DEM creating a new DEM that reflects a continuous levee. The protected area is then treated as a "pool" and, consequently not included in the water surface elevation computations. Figure C.6 shows a (buffered) levee alignment supplied by a user and upstream portion of the "without" levee flood depth grid shown in Figure C.5.

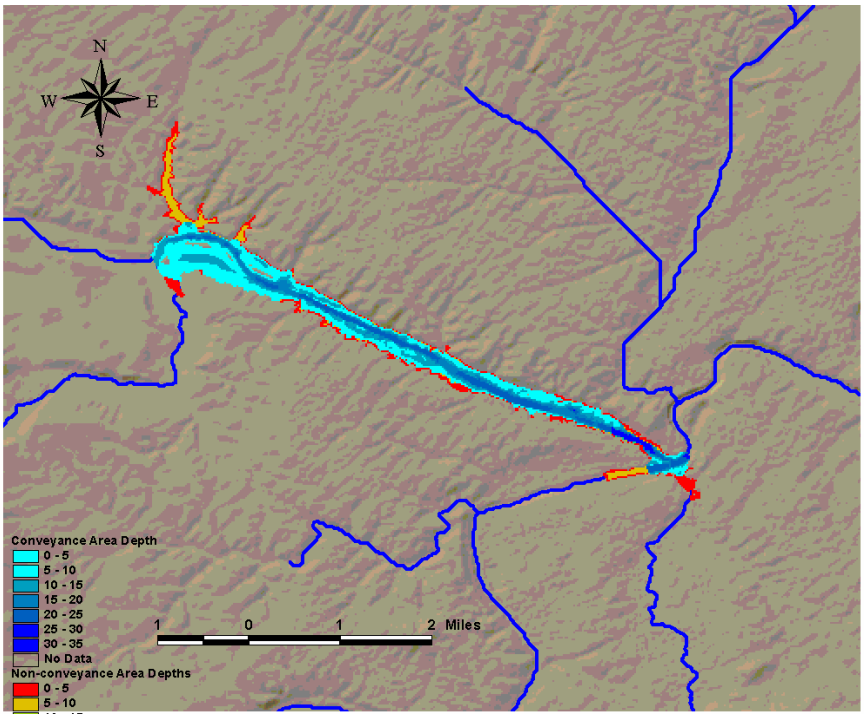


Figure C.5 Flood Depths in Non-conveyance Areas

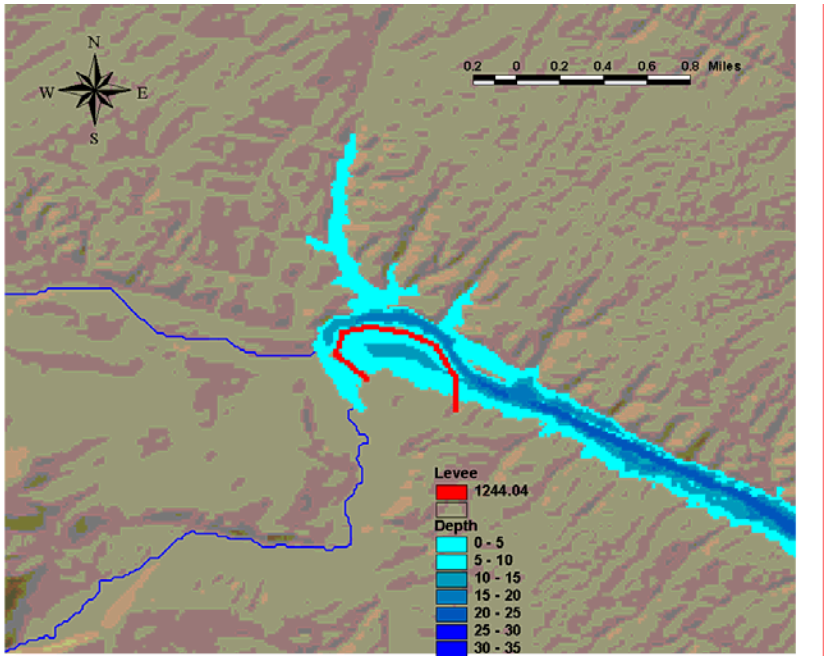


Figure C.6 User-supplied Levee Alignment

Figure C.7 shows the affects of the levee on the flood depth grid. Note the increase in the non-conveyance areas across the stream from the levee.

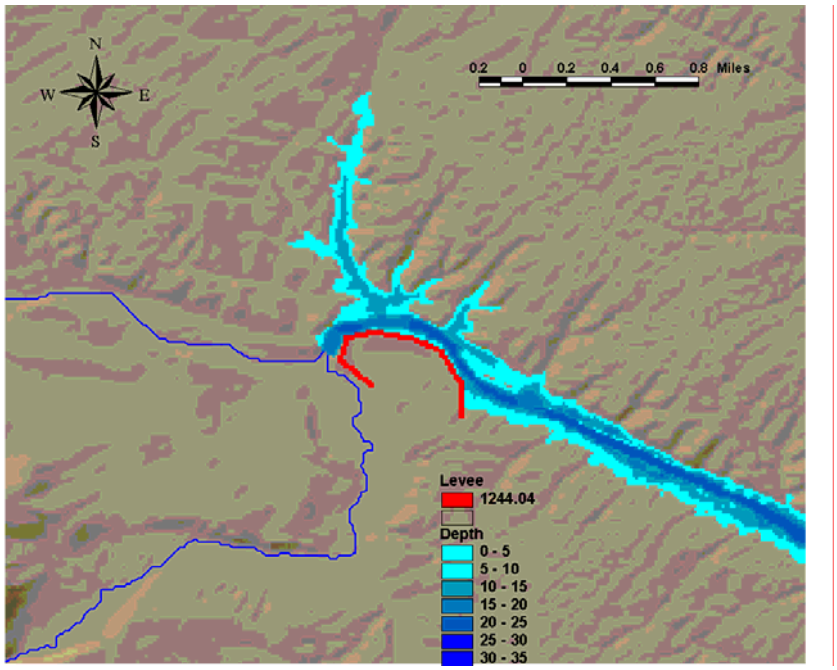


Figure C.7 Affects of Levee on Flood Depths

C.8 Impacts of Flood Warning Systems

The current methodology allows the user to estimate the potential reduction in flood losses due to flood forecasting or warning. The current methodology uses the Day Curves developed by the Chicago District of the US Army Corps of Engineers. The user should review the Flood Model User Manual to see how the dialog is used to modify the damage associated with any given flood. The user, however, should review the Day curves in the Technical Manual to estimate the amount of damage reduction that might be afforded for their community. For example, if the community has historically received only 15 minutes of flood warning, the user can view the curve and estimate the total expected damage reduction based on effective warning and effective response.

The effectiveness of the warning and the effectiveness of the response should drive the users' selection of the expected warning reduction. For example, if the user believes that they can effectively warn the population, either via radio, TV, and perhaps police/fire notification (such as reverse 911) and the user also believes the population understands the notification and effectively responds, then they should select the value provided by the Day Curve. If the user believes there are limitations to this warning and response, then they should select a lower value.